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ELECTRICAL WORLD AND ENGINEER.

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EXPORT TRADE.

The situation in regard to American export trade is very encouraging, not only with respect to agricultural produce of all kinds, but in regard to manufactured articles. There is, in fact, a revival of export trade justifying the hopeful views here taken of the situation, and which bids fair to continue because based on a lower range of prices. The figure of such goods exported in October was $37,558,676, or within a few dollars of October, 1900, the high-water mark. Allowing for difference in prices, it might be found that the recent volume of trade was greater—and for that reason, healthier. We cannot hold foreign markets during periods of abnormal high prices; we cannot even compete abroad at such times; and hence our export trade is in itself a great factor for keeping our domestic prices at a parity with those of the rest of the world; this in turn giving steadiness and reasonability to imports, which simply run into absurd figures when commodities of all kinds reach here the figures that lately were current. The outlook for American manufacturers and for their foreign customers is to-day excellent, and more than ever is it seen that such trade is worthy of sedulous cultivation.

LIGHT AND POWER IN MONTREAL.

Canada has long been the center of some of the best electrical development in the British Empire, and the Toronto street railway system need only be cited as one instance; while this week we draw attention to the work in light and power around Montreal, as another. We question whether any of our readers have realized that Montreal is to-day the greatest center of transmitted power in the world. It seems to us likely that San Francisco, in view of the Standard transmission system, may be in some respects a superior rival to Montreal; but the Standard network is in reality a thing by itself without relation intrinsically at present to such work as is being done steadily every day along the borders of the St. Lawrence.

It will be evident from the article by Mr. Adams, of which we now print the first installment, that the Montreal system is still in a transition state of some complexity, so that the talented young chief engineer, Mr. P. G. Gossler, has been working under very difficult conditions. There has been a great consolidation, and on top of it has come the long-distance transmission problem, to which again such men as Mr. Ralph D. Mershon have had to give their best thought. Within the short time available it has not been possible to reconstruct and harmonize the system as to frequencies, voltages, etc. Hence, the odd periodicity of 63 cycles, due to having to combine and operate in parallel systems originally designed to operate at 66 and 60 cycles. The one has been dropped 5 per cent. and the other raised 5 per cent., to enable paralleling. Another year will probably see uniform phase and periodicity over the whole of the stations. Meantime the story told in this and succeeding issues will be found full of interest.

THE ARC OF ANCIENT DAYS.

An English correspondent of our worthy contemporary, the *American Gas Light Journal,* has been gloating, with obvious satisfaction, over the sputtering of irate British reporters at the very bad behavior of some arc lights at a political meeting in Sheffield. That said arcs were highly improper in their reported action admits of no dispute, but we must look beneath globes to motives before passing too hasty a judgment. Personally, we would rather hear an arc lamp chatter

than listen to the average political speech; but at all events the sensibilities of our British friends seem to have been wounded and our worthy contemporary is promptly at hand with words of consolation. Here in our own country the arc lamp has been taught better manners by a strenuous process of improvement, and we have yet to hear of even a ward primary being broken up by such inconsiderate action. The arc in its state of pristine savagery was an unlovely member of society. But the day of reformation came and in its state of comparative sanctification the arc lamp is a distinguished member of the illuminati. To be serious, arc lighting in Sheffield evidently needs reform, and if such disturbances are common we would advise a liberal importation of American-made arc lamps and the adoption of American methods. Unless we are greatly mistaken, this lighting is done by one of England's vaunted municipal plants. At the present time there is little excuse for bad regulation on arc systems or for sputtering arcs. Even if good arcs were not available, there is the Nernst lamp to fall back upon and some of the finest results ever obtained in the lighting of large buildings have been due to the ordinary incandescent lamp. Any one of the three is vastly preferable to the ghastly greenish emanations from a Welsbach mantle in its chronic state of decrepitude, for a horrible example of which inspect such streets as are alleged to be lighted by that means.

Radium and Helium.

According to cable dispatches, during the past week, Sir William Ramsay, in a recent lecture before the London Institution, made the interesting announcement that his experiments with radium showed that radium has the power of changing into the apparently quite different element, helium. It seems that radium is not content with continuously emitting α-rays, β-rays and γ-rays; but also gives off a heavy gas. When this gas is collected in a glass vacuum tube and sealed off, spectrum analysis indicates that it changes in the course of some days from radium to helium. The rate of emanation has been calculated to be such as would convert radium entirely into helium in the course of two millions of years, if helium be the only substance thrown off. It has been supposed that the matter projected from the cathode in cathode rays, within the Röntgen ray tube, was of a different and more elementary nature, than the matter composing the cathode surface, but the supposed "protyle" was not shot off in sufficient quantities to make its subsequent and independent physical investigation readily possible. Here, however, a certain small quantity of gaseous matter is reported to have one spectroscopic name and nature on first collection, and a quite different name and nature on a subsequent date.

Chemists have always clung to the hope, and cherished the belief, that the list of seventy odd elements might be curtailed. All these elements were considered as substances which had not yet yielded to further or more remote analysis. It may, however, at any time, be found possible to reduce some element or elements to yet more elementary forms. The old alchemists sought vainly to convert one metal to another. The recent conclusions of physicists that atoms of substances are complex structures, of which ions are the component parts, has paved the way for the revived belief that matter is evanescent in type, and that it may be capable of being changed from one substance to another, either by internal forces in cases of particular instability, or by external forces, such as those that exist in the neighborhood of a Röntgen ray tube cathode surface. It now seems as though radium may be one of those forms of matter which exists in a condition of ionic or subatomic instability, and that radium may be constantly breaking down subatomically, with a disengagement of energy, to form a new and more stable subatomic structure or structures, such as helium. The very possibility of such a condition opens to the mind a new universe and a new range of speculation. The stellar visible universe appears to consist of masses of matter describing in many instances planetary orbits in cyclic paths about local centers of gravity. The microcosm of a single atom may perhaps be but a minified planetary system, in which ions, or groups of ions, perform orbits of corresponding small periods and dimensions. One particular orbital arrangement may represent sodium and another platinum.

Prof. Ramsay is quoted as saying that the price of radium had risen tenfold during the past half-year, owing to the Austrian Government having suppressed all further exportation of refuse from the uranium oxide works at Joachimthal, a town in Bohemia. Radium never has been cheap. Prior to the corner by the Austrian Government, the price quoted was six thousand dollars per gramme, or nearly three millions of dollars a pound. If the price now quoted is ten times greater, it would be about twenty-seven millions of dollars per pound, avoirdupois. It is said that there are men in the United States worth one hundred millions of dollars. How interesting it must be for such persons to reflect that they are worth nearly four pounds of radium. If, however, it is true that radium minus radiation energy equals helium, then it may be found possible, perhaps, to energize and invigorate helium in some way and make it into radium. This might soon hurt the market; but at first it would seem as though such a procedure, assumed as possible, might be distinctly profitable.

Street Railway Conduit Limitations.

For many years past this journal has advocated the claims and merits of the underrunning trolley conduit style of street railway wherever density of passenger traffic and other conditions render its adoption feasible, and we have been glad to witness its widespread introduction into New York City. There are places, however, for which it is not only ill-suited, but impossible, and one of these is most assuredly West Street, New York, where the local traction interests are now trying to secure the right to install the overhead trolley instead of the antiquated horse cars that have so long lumbered up the tracks and hindered rather than expedited travel. In view of the opposition offered in some quarters, a few comments are in order. It is not altogether with satisfaction that we contemplate the fact that New York City is the last great stronghold of the once ubiquitous horse car. There are to-day more horse cars in the metropolis than in all the rest of the United States put together, and we are not proud of the distinction. It is peculiarly galling that the foreigner landing at one of the great piers should, for his first glimpse of the much-vaunted American rapid transit, catch sight of one of the battle-scarred veterans that rattle their bones over the West Street track. There seems to be an altogether unreasoning prejudice against the installation of an overhead trolley system in that situation. It is a situation where draining a conduit thoroughly enough to keep it in working order is out of the question. Conduit working has been found successful wherever the conduit can be kept clear enough of water to allow of a fair degree of insulation, but with West Street at its present grade insulation is a hopeless task. It is a place where occupancy is secured only by the incessant use of the pump in basement and cellar.

There seems, on the other hand, to be no adequate reason why the overhead trolley should not be used there with entire success. A trolley system when reduced to merely the working conductors and their suspensions, is unobtrusive, and, indeed, the wires are hardly noticeable in glancing down such a street. If necessary, the trolley wires could be run higher than usual, so as to accommodate the

truck-load of maximum height. No street in New York has more acute need of rapid transit facilities. We are disposed to think that the real reason for the opposition which has appeared is not in the least based upon æsthetic grounds nor upon the fear of establishing a precedent. It results, we think, from a recognition of the fact that where the electric car comes, the obstructive truck must hustle or make way for it. In plain words, certain interests for their private advantage want to keep West Street reserved for their slow trucking, utterly regardless of the rights and wishes of the hundreds of thousands of citizens going and coming from the Jersey shore who daily are compelled to frequent it. As long as the dingy old horse cars stay, those cars can be neatly trapped into blockades and rendered so unpopular that the call for rapid transit will be smothered. Once modern trolley cars are placed in service and the track rebuilt to meet the new requirements, trucks will be compelled to give the cars a fair show on their own tracks, and the present clattering, jamming, loud-swearing monopoly will be at an end. Here as everywhere the electric road stands for the rights of the people against the special privileges of the few.

Our own opinion is that in most cities—not all—an overhead trolley system reduced to its lowest terms, with all feeders underground and no overhead wires of other systems to fall upon the working conductors, is altogether more satisfactory than a slotted conduit system. The slot rail there is, from a practical standpoint, more objectionable than the overhead structure. To object to the latter on æsthetic grounds is rank hypocrisy, for neither civic pride nor a sense of artistic propriety ever seems to hinder disfigurement of the streets when dollars are in sight. A city that tolerates abominations like the "Flatiron" Building and allows its downtown sidewalks to be obstructed by skids and packages at all hours of the day cuts but a sorry figure while protesting against trolley wires in the name of "Art." A well-installed trolley system on West Street would be an immense convenience to the whole west-bound population of the city and would give the city a water front of which it need not be ashamed. The objectors merely want to keep on converting the public street to their private ends, driving off its legitimate owners by making the street continually impassable. The West Street ride in trolley cars would be one of the most enjoyable in the city, improving the property there to an untold degree also. To-day the street is a damp and dingy avenue of dilatory traffic and everybody suffers, not only at every high tide, but every day of the year.

THE HEREDITY FACTOR IN TECHNOLOGICAL EDUCATION.

In a lecture recently delivered in London, Prof. Karl Pearson declared that he had set himself the problem, six or seven years ago, of determining how far mental and moral qualities and capabilities were inherited, as compared with physical characteristics. In other words, how far are health, good temper and aptitude in science inherited by comparison with the inheritance of such readily determinable physical characteristics as stature, muscular strength, or color of hair. This problem opened up the necessity for three collateral lines of inquiry: First, a measurement of the extent to which physical characteristics are inherited in man; second, a comparison of the inheritance of physical characteristics in man, with respect to inheritance in other living things—e. g., man compared with horses; third, a measurement of the extent to which mental and moral characteristics are inherited in man.

The method of measurement as described was very interesting and depends upon hereditary conditions discovered by Galton for both human beings and sweet peas. This is the principle of fraternal regression, and may be described as follows: If one member of a family of brothers is found to deviate from the general average of the community by a given amount in a certain physical characteristic, as for example, by being two inches above the normal mean stature, the other brothers will tend to have an average deviation of half that amount, or in the case considered, by one inch in excess. If the most devious member has a certain deviation, the average other brother will be divided in his allegiance between the devious brother and the common stock and will have half the deviation, on the average. This is a property which is said to run through both plants and animals and to be a characteristic of physical heredity in general. It is closely connected with the quantitative degree of inheritance from father to son; and is a characteristic which can be applied without taking in more than a single generation, since it only needs observations on a large number of members of a community in which brothers exist. Any physical quality or proclivity is found to be distributed in a large community according to the laws of errors in observations; i. e., equal small numbers of large and opposite deviations from the mean, and equal increasing numbers of lessening opposite deviations from the mean, with the great majority having nearly the mean value. Thus in height, or strength, or color, or any physical measurable quantity, the great mass of the people deviate but little from the mean, but deviations occur equally often above and below, and are distributed like accidental errors in the use of a measuring instrument.

Prof. Pearson measured the fraternal regression in regard to physical characteristics of young people by sending 6,000 circulars to about 200 schools, and obtaining reports upon measured physical properties of the students. In all of these the fraternal regression was found to come out close to one-half. A very large number of observations were next compiled upon 1,918 pairs of brothers as to mental and moral characteristics, and the result of this investigation showed that the fraternal regression was also very close to one-half, within the limits of observational error. Similar conclusions have been arrived at as to the fraternal regression in physical characteristics of other living things. Prof. Pearson concludes finally that mental and moral aptitude of any kind are inherited according to the same law as applies to physical variations. The result has a very important bearing upon education, for it is useless to expect great results from education, if applied to inapt students. Great success in education can only be hoped from the application of good education to gifted or apt pupils, and the aptitude can be stimulated, but cannot be created. It must be inherited and follow the laws of heredity, which are seemingly erratic in the single individual, but which are perfectly definite and reliable in the mass of individuals. If the talented classes of a nation do not proportionately reproduce themselves in the succeeding generation, the nation will decay in talent. Prof. Pearson, speaking in England, regards it as probable that an era of great dearth of ability is approaching, because the more talented classes are found to be failing in vitality and relative reproductiveness. He considers that the progress of a nation lies largely in the hands of the most advanced citizens, those who deviate positively most from the great mediocrity of the nation in respect to mentality of various kinds. These deviations are always to be expected by the laws of error, but they can be fostered and magnified by any stimulation of the reproductiveness of the individuals possessing them. On the other hand, any systematic means for causing the more intellectual deviations to disappear has a great depressing influence on the future of a nation; as for instance, the action of the Spanish inquisition, maintained steadily for several centuries, in eliminating and killing intelligent heretics.

American Central Station Statistics.

Mr. W. M. Steuart, chief statistician of the United States Census Office, has just issued a most interesting and important preliminary bulletin devoted to electric light and power stations for the year ending June 30, 1902. A few figures relating to the report were issued a month or two ago and this bulletin will be followed up by a more elaborate and complete report. As it is the present document embraces no fewer than 50 tables, which, with the running discussion on them, constitute the first thorough treatment of the kind that this great industry has yet received; and laying the foundation for all such statistical work in the future. We shall have occasion to return to this subject, and to present many of these tables and accompanying remarks to our readers. For the moment it must suffice to note that at the time of the enumeration there were 3,620 central electric stations in operation. The cost of their construction and equipment amounted to $504,740,352. The gross income for the year was reported at $85,700,605, and the total expenses at $68,081,375. These stations furnished employment to 23,330 wage earners, who received $14,983,112 as wages during the year. The power plant equipment consisted of 5,930 steam engines with 1,379,941 indicated horse-power, and 1,390 water wheels with a stated horse-power of 438,472. The generating plants consisted of 12,484 dynamos of every description with a stated horse-power of 1,624,980. A noteworthy feature of the development of this industry has been the installation of plants operated under the control of municipalities. There were 815 of these plants in operation. The cost of their construction and equipment was reported at $22,020,473. They gave employment to 2,467 wage earners and paid $1,422,341 in wages. These figures do not, however, tell the full central station story, as during the same year there were 252 electric railways doing a central station business as previously noted in these pages; nor, of course, are any data presented from the 50,000 isolated plants—more or less—that exist all over the country. The current output for the year is estimated and returned at 2,453,502,652 kw-hours, or about 25 per cent. of the possible work that the stations could do in 24 hours of daily operation.

The general introduction of electric lighting is shown by the fact that of the 1,892 places reported at the Twelfth Census as having a population of 2,500 and over, 1,511 had one or more central electric stations operated either independently or in connection with an electric railway, and there were 1,960 places with a smaller population having similar stations. In addition, there were a number of large central electric stations which furnished current to surrounding cities, towns and villages, so that an enumeration of the places in which central stations were located by no means represents the distribution of the current. Moreover, the term "central electric station," as used in this report, includes a number of plants, but in cases where two or more plants were operated by the same individual, firm or corporation, and located in the same State, a separate report was secured for each whenever the system of accounts permitted the preparation of separate returns; otherwise, one report was obtained to cover the operations of all plants. For instance, the Edison Electric Company, of Los Angeles, Cal., generates current in three mountain water power plants and four steam plants in different localities, all connected by transmission lines. These seven plants were included in one report and were counted as one station. There were 1,463 central electric stations operated by private companies or municipalities in connection with the manufacture of gas, the operation of water works, or other industries. It is very interesting to note that there were only 827 cities and towns in which one or more gas plants were in operation. The fact that 75 per cent. of the central electric stations are in places of less than 5,000 inhabitants, as compared with 22.8 per cent. of the gas plants, indicates the wider distribution of the electric stations which have enabled the inhabitants of the small places to enjoy illuminating facilities.

More than 150 private and municipal stations have commenced operations during each year since 1888, and in each of nine years since that date more than 200 have been installed, the greatest number, 277, being reported for the year 1898. Each State and territory contains a number of central electric stations operated under private ownership, and all, with the exception of three territories, and the District of Columbia, Nevada and Wyoming, report one or more municipal stations. Illinois contains the greatest number of stations operated under private ownership and Ohio the greatest number under municipal control. The greatest proportion of central electric stations is found in the North Central States. In 1890 these States contained 43.1 per cent. of all the electric stations in the United States, and in 1902 the proportion had increased to 47.1 per cent. The greatest percentage of increase in the number of stations is shown for the South Central States, where 79 stations had been installed up to 1890. This number increased to 404 in 1902, or 411.4 per cent. Of the total number of stations reported, 2,805, or 77.5 per cent., were operated under private or corporate ownership and 815, or 22.5 per cent., under municipal control. There were 13 stations operated under private ownership in 1902 that were formerly under municipal control. Of the 815 municipal stations, 77 commenced operation under individual or partnership control and 93 under corporate ownership. A further division of stations operated under private ownership is made in Table 34, from which it appears that 964 stations, or 34.4 per cent., were installed by individuals or firms, and 1,828, or 65.2 per cent., by corporations. At the time of the enumeration in 1902, the number of stations operated by individuals or private firms had been reduced to 756, or 27 per cent., while the number controlled by corporations had increased to 2,049, or 73 per cent.

Ramsay on Radium and Helium.

Sir William Ramsay, professor of chemistry at University College, London, who, with Lord Rayleigh, separated helium from the air, in a lecture last week before the London Institution, made the interesting announcement that his experiments with radium had shown that that element has the power of changing by some subtle process into another element, namely, helium. He described how a long search into the problem of what becomes of the minute particles with which radium is always parting was quite lately rewarded. Besides its other manifestations, radium constantly gives off an emanation which seems to behave in all respects like a heavy gas. It can be collected in tiny flasks, measured, weighed and used to display the characteristic properties of radium, but it is not permanent. In about a month it entirely disappears. The question is, "What becomes of it?" Sir William has caught this emanation in the act of vanishing. He found that after it had been collected a couple of days its spectrum, which previously was entirely unlike any yet studied, began to display the typical yellow line of helium.

In four or five days the helium grew brighter, and in another week the spectrum of helium was positively blazing in the hermetically sealed tubes that had been filled with the pure emanations or gaseous output of radium. In other words, one element had been literally seen to change into another.

This realization of one of the oldest of human dreams was, said Prof. Ramsay, very suggestive of transmutation. The problem might not be actually solved, but it was by no means absurd. Prof. Ramsay calculated that if radium turned into helium and nothing else it would take 2,000,000 years to dissolve into gas, but if helium is only one of the substances given off the transmutation would be proportionally shorter. He is now investigating to learn precisely how much helium was produced from the radium, what happened in the change and how long it took. He pointed out that several groups of elements linked together by Mendeljeff's periodic law showed a remarkable similarity of properties, tending to suggest that the accepted elements were not the final forms of matter, and that they were ultimately reduced into a few simpler forms. He asked if the world was on the verge of some great generalization, showing that all the so-called elements were merely elusive forms of one or two fundamental kinds of matter.

Prof. Ramsay stated that Profs. Rutherford and Soddy were cooperating with him in his investigations. He incidentally remarked that the price of radium had increased ten fold in the last six months, owing to the action of the Austrian Government, which had created a corner therein by refusing to allow further exports of refuse from the uranium oxide works at Joachimthal. As a result, the nominal price of radium is about $250,000 for one-fifteenth of an ounce.

Among a number of other interesting points the lecture showed the power of radium to make certain minerals and chemical compounds luminous. Prof. Ramsay subjected a piece of the mineral willemite to the "bombardment" of radium particles, whereupon it shone brightly. In an interview after the lecture Sir William said it was practically impossible at present to obtain more radium. It had been said that an American company had been formed to mine it, but he had tested the American ores supposed to contain it and found them absolutely worthless.

Montreal, the Greatest Centre of Transmitted Power--I.

BY ALTON D. ADAMS.

INTRODUCTION.

FIG. I.—REAR VIEW OF CENTRAL STATION.

MONTREAL, Canada, consumes more electrically-transmitted water power than any other city in the world. This power is drawn from three generating stations located on as many different rivers at distances that range up to about 85 miles from the central sub-station in the city. These rivers, the St. Lawrence, the Richelieu and the St. Maurice, draw their water supplies from half a continent. With the vast drainage area of the Great Lakes behind the St. Lawrence, the entire Champlain Basin between the Green and Adirondack Mountains to gather water for the Richelieu, and a great stretch of northern Canada to supply the St. Maurice River, the reliability of electrical supply from water power is assured in Montreal. The superlative capacity of the water-driven apparatus in this electrical supply system seems evident from a statement of the figures for the generating and sub-stations. At Chambly power house, on the Richelieu River, 17 miles by the transmission line from the central sub-station in Montreal, the combined capacity of the main electric generators is 16,800 kw. The Lachine power house, on the St. Lawrence, five miles from the sub-station just named, contains main generators of 6,000 kw total capacity. Both of these power plants are devoted exclusively to the operation of the Montreal system. Neglecting the total equipment of the great power house at Shawinigan Falls, on the St. Maurice River, which is operating under a head of 145 ft., and in which three turbines are installed at present, having a capacity of 6,000 hp each, and generators of 3,750 kw, and whence energy is transmitted 85 miles to a sub-station in the suburbs of Montreal, the capacity of transformers at this sub-station is 5,000 kw, and they require about 6,000 kw in generator capacity at the Shawinigan plant. The total rating of the present generators in water-power stations, devoted to electrical supply in Montreal, is thus 28,800 kw. This capacity will shortly be increased in two directions. A fifty-year contract requires the company operating the Shawinigan plant to deliver up to 20,000 hp for electrical supply in Montreal. Still another water power located at Soulanges, on the St. Lawrence, is about to be developed and transmitted for the city system.

In anticipation of the increase of capacity at the water power plants the sub-stations in Montreal have been equipped beyond immediate requirements. Besides that of the Shawinigan system already mentioned, there are two sub-stations in Montreal devoted to general electrical supply. At one of these, known as the McCord Street sub-station, the total capacity of transformers that receive the high-tension transmitted energy is 7,000 kw. In the main or central sub-station, the total capacity of transformers connected to the transmission lines is now 27,500 kw with room for an increase. Including the 5,000 kw at the Shawinigan sub-station, which is entirely devoted to the Montreal electrical supply system, save for one item of 250 hp, the combined capacity of stepdown transformers is thus 39,500 kw or 52,000 hp. It is safe to say that no other city on the American continent, or even in the world, has an equal capacity of stepdown transformers delivering energy from water powers to an electrical supply system for all purposes.

Besides the water-power plants and sub-stations already named, the system includes five steam power stations at as many points about the city and suburbs, with a combined capacity of 5,700 kw. These steam plants are in large part a legacy of former conditions, and are now held as a reserve for the water power system. The largest of these steam-driven stations, that on Queen Street, has a capacity of 2,400 kw, and has been remodelled and made fire-proof during the past year.

THE AREA OF SUPPLY.

Electric light and power supply is distributed by the Montreal system in the city and island of that name for a distance of about fourteen miles along the river front, and to an average width of between three and four miles back from its bank. Included in the service area is a strip of territory about one mile wide and four miles long on the main land opposite to the city. Within this area there are at present served 11,152 customers using commercial arc and incandescent lamps, and 870 customers using motors, besides the cities and towns that are supplied with street lamps. The municipalities whose streets are lighted number fifteen, including Montreal, and all except two of these are on the island. The total connected load of street lamps numbers 1,717 of the arc and 577 of the incandescent type. Commercial lighting service is rendered to 11,152 customers, who have connected to the system 299,903 incandescent lamps, 1,514 arc lamps and 405 pieces of various apparatus, such as fans and heaters. Power service is rendered to no fewer than 870 consumers, who employ 1,109 electric motors with an aggregate capacity of 19,172 hp. From these figures it may be noted that the utilization of water powers has made the operation of motors an exceptionally important part of the business of the Montreal system. The commercial lamps above named, together with a part of the incandescent street lamps, are operated through 2,161 service transformers with an aggregate capacity of 13,249 kw. For the motor load 695 transformers with a total capacity of 6,980 kw are employed, but these transformers do not operate all of the connected motors, because many of these motors are of the direct-current type, and many of the alternating motors operate at the full voltage of distribution so that no transformers for them were required.

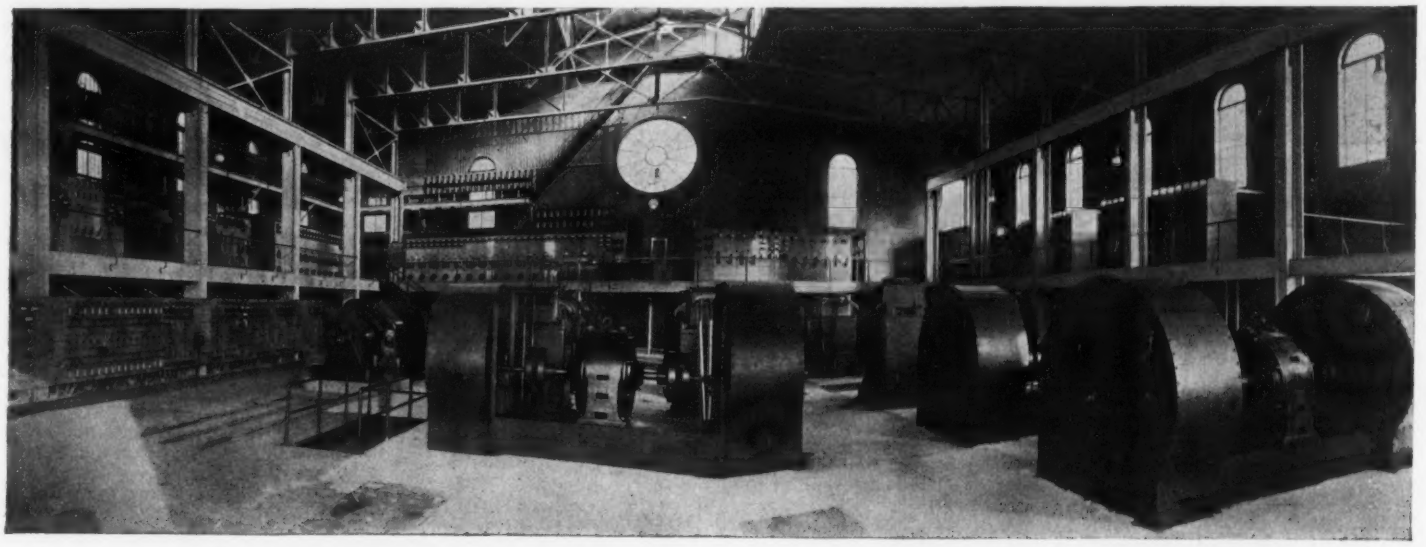


FIG. 2.—GENERAL VIEW OF INTERIOR OF CENTRAL STATION, MONTREAL.

WHAT CONSTITUTES THE SYSTEM.

This great system, which constitutes the only public supply of light and power in Montreal, has been welded together out of diverse elements. The Montreal Light, Heat and Power Company, the owner of the system, was incorporated by the Quebec Legislature in March, 1901, for the purpose of consolidating all the gas and electric companies doing business in the city. In conformity with this

purpose the charter of the company authorizes it to acquire plants for the supply of gas, electricity or other source of light, heat or power, by purchase, lease or otherwise. Furthermore, the company may lease and operate all or any part of the plants of any other company engaged in the supply of light, heat and power, and may acquire and hold the stocks and bonds of any such corporation. When the Montreal Light, Heat and Power Company has acquired the plant of any other company engaged in similar lines of business, then the Montreal Company may exercise the charter rights and franchises of such other company. Besides the foregoing powers, the Montreal Company has the right to construct its pipes, lines and conduits under or over the public streets and highway of that city or of any place or territory within one hundred miles therefrom in any direction.

Pursuant to these liberal and important powers the Montreal Light, Heat and Power Company acquired a majority of all the capital stock of each of the following named companies: The Montreal Gas Company, the Royal Electric Company, the Montreal & St. Lawrence Light & Power Company, the Imperial Electric Light Company, Ltd., the Lachine Rapids Hydraulic & Land Co., Ltd., the Standard Light and Power Company, the Citizens' Light & Power

FIG. 3.—FRONT VIEW OF CENTRAL STATION.

Company, Ltd., the Temple Electric Company. The Montreal Light, Heat and Power Company, together with the eight subsidiary companies just named, controls the entire supply of gas and electrical energy in that city and its suburbs. The dates of incorporation of these subsidiary companies are of interest as showing the great increase in public service that has resulted from the introduction of electrical supply and the application of water power therein. The Montreal Gas Company was incorporated in 1847, and engaged in the supply of gas in Montreal and its suburbs. In 1884 the Royal Electric Company was chartered to supply electrical energy in Montreal, and at the time of the consolidation was the largest distributor of that product in the city. The Montreal & St. Lawrence Light and Power Company was incorporated in 1888, and has built the large hydro-electric plant at Chambly, that now forms a part of the Montreal electric system, and transmitted the energy there developed to the city. Energy from this plant was first used at Montreal in August, 1899. The Imperial Electric Light Company was chartered in 1896 to supply electrical energy in Montreal from a steam power plant. The Lachine Rapids Hydraulic Land Company, Limited, was incorporated, in 1896, to develop the Lachine Rapids and transmit electrical energy therefrom for use in Montreal, which has since been done. Both the Citizens' Light and Power Company and the Standard Light and Power Company were incorporated in 1892 for the purpose of either gas or electrical supply.

From the above it appears that the Royal Electric Company, one of the subsidary corporations just mentioned, is the oldest of those now engaged in electrical supply in Montreal, as its formation dates from 1884. It would be interesting, if possible, to trace the increase of electric loads among all the companies at Montreal during past years, but the facts are not at hand for any of these companies save the Royal Electric. Figures for the loads of this company are, however, no doubt more representative and larger than figures for any one of the other companies concerned. Direct-current arc lamps connected to the circuits of the Royal Electric Company numbered 1,287 in the year 1890; 1,666 in 1895, and 1,859 in 1900, showing an increase of 44 per cent. during the ten years. During the same period the load of arc and incandescent lamps on the alternating-current circuits rose from an equivalent of 1,835 incandescent lamps of 16 cp each to an equivalent of 93,498. In other words, the load of arc and incandescent lamps on alternating circuits was 59 times as great in 1900 as it was in 1890. Direct-current motors first appeared on the circuits of the Royal Electric Company in 1892, when their total rating was only 50 hp, but by 1900 this capacity had risen to 1,253 hp, or 25 times the rating in the earlier year. The latest factor in the electric load was the alternating-current motor, which did not appear in the returns until 1897, and was then credited with a combined rating of 18 hp. Three years later, in 1900, the capacity in connected motors of this type reached 3,417 hp, representing an average addition of more than 1,100 hp in capacity yearly. It is hard to believe that this rapid increase of electrical loads was not due in some measure to the utilization of water power, for between May 31, 1899, and May 31, 1900, the Royal Electric Company secured control of the hydro-electric plant at Chambly, energy from that plant was delivered at Montreal in August, 1899, and the rise of electric loads was more rapid during the year between the two dates just named than in any other of the decade. Thus, during the twelve months that ended May 31, 1900, the increase on the Royal system of the equivalent load of 16 cp incandescent lamps was 14,460, and the rise of capacity in connected motors was 116 hp for those of the direct-current, and 2,176 hp for those of the alternating type. To water power must also be traced the strong tendency to consolidation that culminated in 1901.

The charters of the Montreal Light, Heat and Power Company and of its subsidiary companies are perpetual, and the stockholders of the former company, by a vote of two-thirds of the stock represented at any special general meeting called for the purpose, may increase its capital stock to any amount deemed necessary for its purposes. Debenture bonds may be issued by the company to an amount equal to 75 per cent. of its capital stock, and these bonds may be secured by a transfer to trustees of all or any part of its assets. Up to April 30, 1903, the Montreal Light, Heat & Power Company had issued $17,000,000 in capital stock, and $3,500,000 in 4½ per cent. bonds. During the year ending at the date just named, the excess

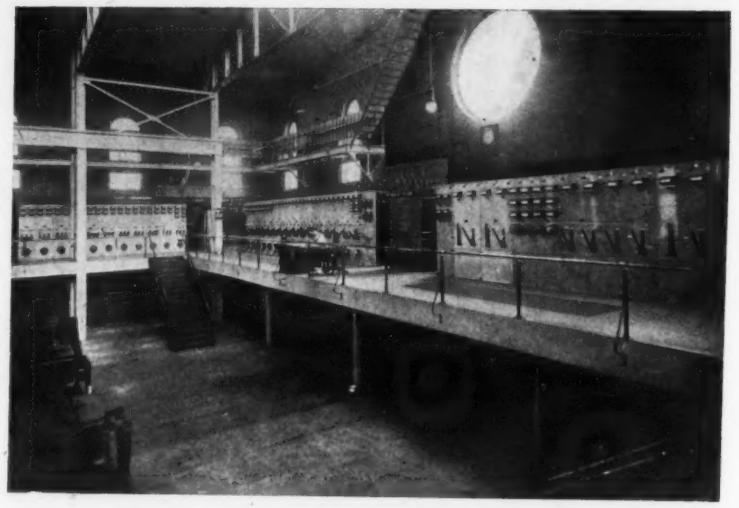


FIG. 4.—DISTRIBUTING SWITCHBOARD AND TRANSFORMER PANELS.

of earnings by the company over its operating expenses was $900,872.95. This excess of earnings over operating expenses amounted to 46 per cent. of the gross earnings of the company in that year. For the year ending April 30, 1902, the first after the formation of the Montreal Light, Heat & Power Company, the company earned $821,217.45 above the expenses of operation, and this sum was 46 per cent. of its gross earnings in that year. Besides paying all operating expenses and interest charges on its bonds and loans the Montreal company declared four quarterly dividends of 1 per cent. each, during each of the two fiscal years just named, the only ones of its existence. After all these payments there remained a surplus of over $140,000.

FEATURES OF DISTRIBUTION.

Electrical supply in Montreal and its suburbs is distributed from three sub-stations, which are designated as the central, the McCord Street, and the Shawinigan sub-station respectively. The central sub-station is nearest of the three to the business center of the city, the McCord Street sub-station is about one-half mile distant to the west, and

the Shawinigan sub-station is approximately 3⅝ miles to the east. At each of these sub-stations the energy transmitted from one or more of the water power plants is transformed or transformed and converted to alternating current at 2,400 volts, 63 cycles per second, and either two or three-phase. At the central sub-station a portion of this 2,400-volt alternating current is transformed to 4,000-volt constant current for the series arc lamps, and another portion of the 2,400-volt current is transformed and converted to direct current at 250 volts for a three-wire system of 500 volts between outside wires, that carries a part of the motor load. All three of the sub-stations are tied together by the 2,400-volt feeders, so that the energy received from either water power plant may be delivered to consumers on any part of the distribution system. Constant, direct current is supplied for a part of the series street lamps by means of motor-driven arc dynamos.

Of the total number of arc street lamps, 1,717, the enclosed series alternating arcs comprise 1,333, and the remaining 384 lamps are of the series open direct-current type. All of these street arc lamps are of nominal 2,000 cp each. The enclosed alternating arcs operate nominally on 80 volts and 7.5 amp. each, or 480 actual watts. On the direct-current arc lines the rating is 9.6 amp.

Of the 577 incandescent street lamps, 106 of 65 cp and 273 of 32 cp are on the constant alternating-current lines, 37 of 32 cp are operated by constant direct-current circuits, 50 of 32 cp are in multiple

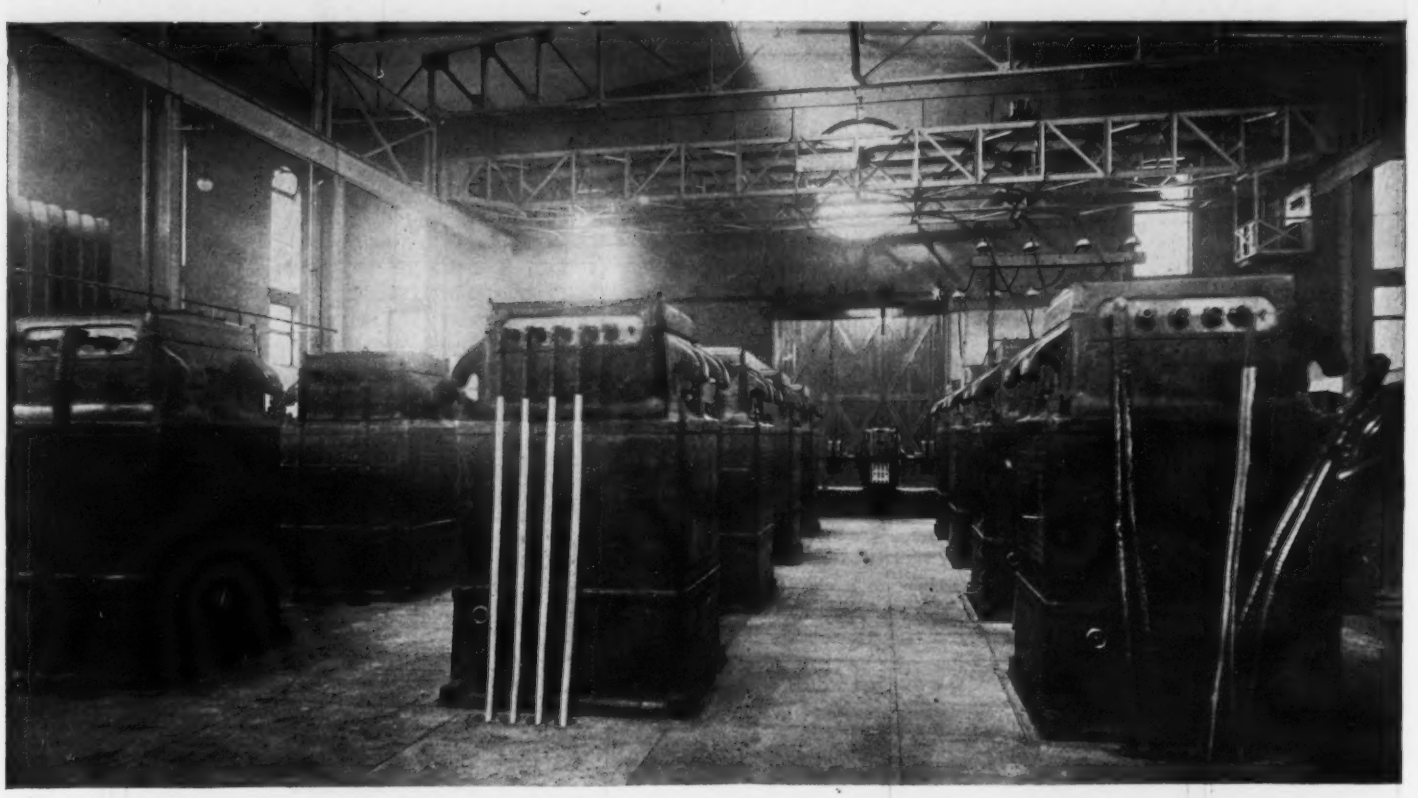


FIG. 5.—TRANSFORMERS, CENTRAL STATION.

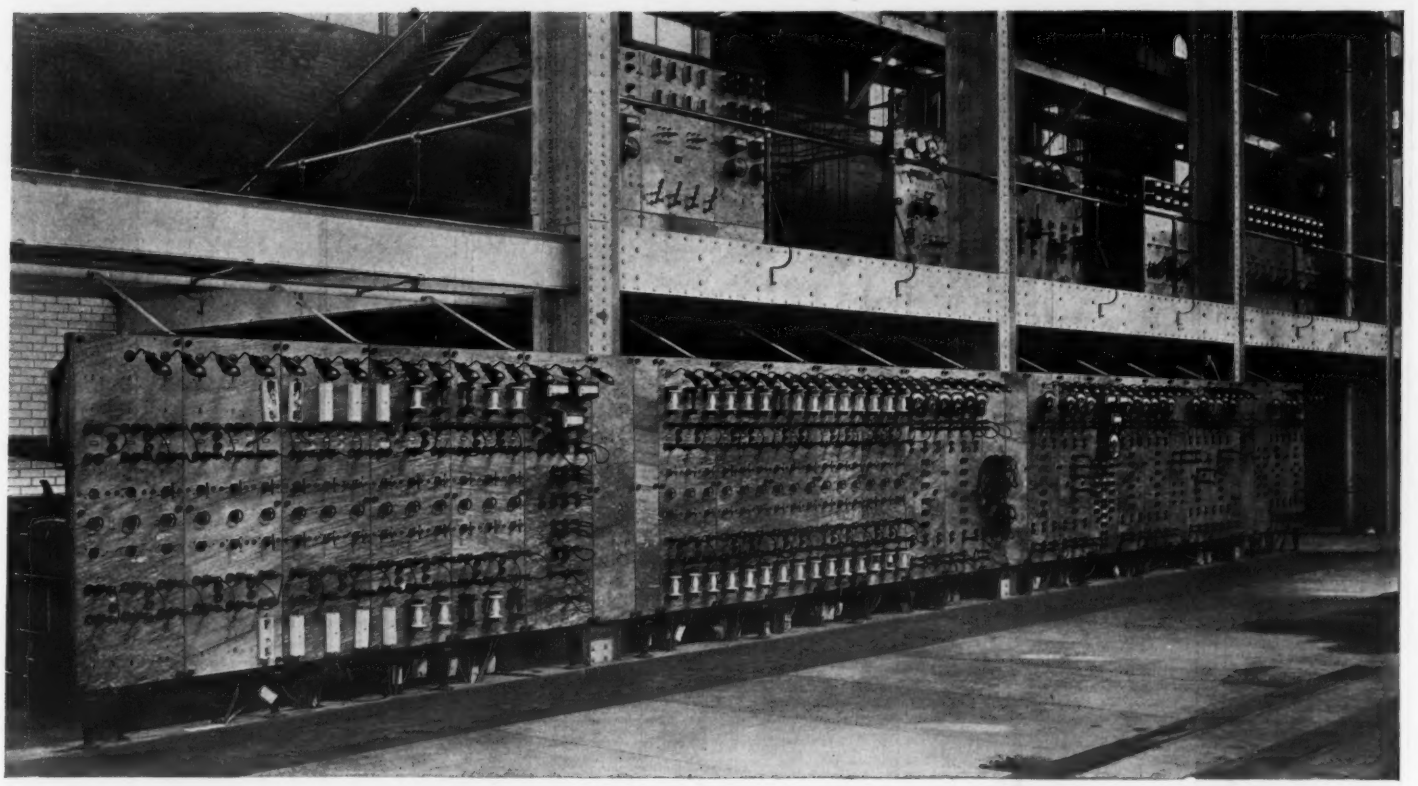
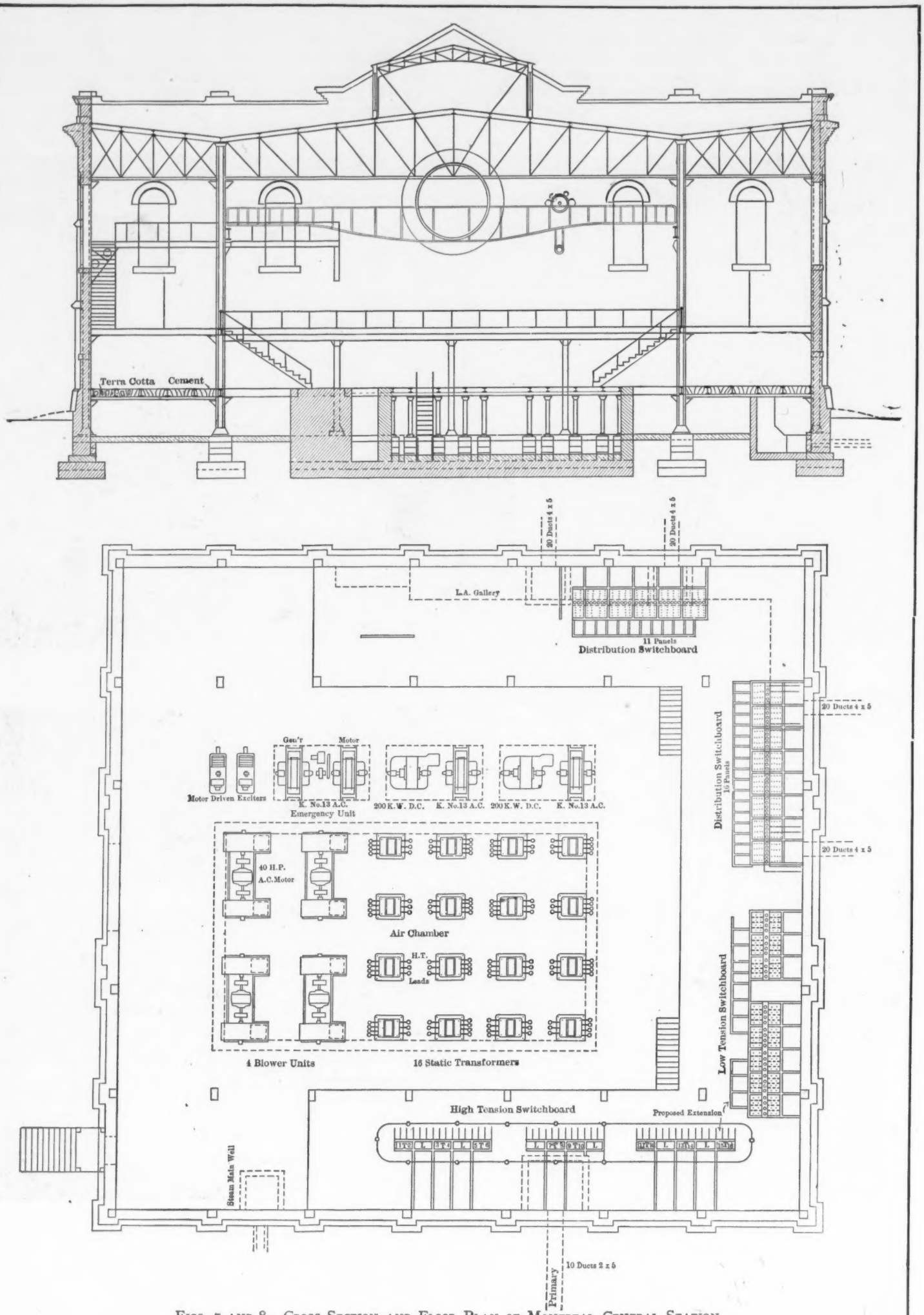


FIG. 6.—SWITCHBOARD FOR CITY LIGHTING.



FIGS. 7 AND 8.—CROSS-SECTION AND FLOOR PLAN OF MONTREAL CENTRAL STATION.

on the 220-volt system, and 91 of 32 cp and 18 of 16 cp each are in multiple at 110 volts. The 299,903 incandescent lamps in commercial service include a variety of candle-powers below 16, so that the equivalent number of 16-cp lamps would be somewhat less than this total figure. The constant-potential commercial arc lamps of both the enclosed and open types number 1,277 on alternating circuits. Commercial service also includes 23 constant-current, enclosed alternating arcs and 214 direct-current series open arc lamps.

Most notable in this supply system is the load of stationary motors, because of their large number, great aggregate capacity and the unusual average capacity of each. Of the 1,109 motors connected to the distribution lines, 580 motors in use by 426 customers are of the alternating type and have an aggregate capacity of 16,556 hp, giving an average capacity of 28.4 hp each. Comparing these motors with the number of customers using them, it appears that the average was 1.36 motors and 38.8 hp per customer. The exceptionally large average horse-power per motor and per customer points clearly to the extensive use of these alternating motors in manufacturing operations. Some of these alternating motors are of the synchronous, but the greater number is of the induction type, and all are supplied with current of 63 cycles and either two or three-phase. Most of these motors are operated from the 2,400-volt circuits through transformers that lower the voltage to about 550; but some of the large sizes receive the full line voltage in their windings. Direct-current motors number 529, are in use by 444 customers and have an aggregate capacity of 2,616 hp. The average capacity of these motors is thus almost 5 hp each, and the average per customer is 1.2 motors and 6 hp. Comparing these figures with those for alternating motors it appears that the average power per customer and per motor is nearly six times as great for the alternating as for the direct-current type. From this fact the obvious conclusion is that the alternating type of motor is more generally applied where comparatively large powers are required. The two largest consumers of electric power connected to the Montreal system—that is, the Montreal Street Railway Company and the Dominion Cotton Mills Company—use 21 motors of the alternating type that have an aggregate capacity of 8,005 hp, besides some smaller sizes. If the number of these exceptionally large motors and their total capacity are deducted from the corresponding figures for all motors of the alternating type, the result shows 559 of these motors with a combined rating of 8,551 hp. These last-named figures correspond to a capacity of 15.3 hp per motor on an average, or 2.5 that of the like average for all of the direct-current motors. This again brings out the fact that the alternating motors have been more generally selected than the direct-current type by the users of large amounts of power.

The Montreal Street Railway Company has a larger capacity in motors connected to the system of the Montreal Light, Heat & Power Company than any of its other customers. This capacity amounts to a total of 4,915 hp and is made up by seven 2,200-volt, two-phase motors that operate with alternating current of 63 cycles per second. Six of these motors are of the induction type and rated at 700 hp each, while the seventh is a synchronous motor of 715 hp. For the supply of energy to these motors seven two-phase circuits are run from the central sub-station of the electrical supply system to the generating station of the street railway company, a few blocks distant. These induction motors are believed to be among the largest of this type in use anywhere. It is believed that these induction motors require less skill in their operation, and cause less fluctuation of voltage in the electric supply system than synchronous motors of equal capacity. On the other hand, one disadvantage of induction motors, that of a very short air-gap between the rotating and stationary parts, is here illustrated. Thus, in these great induction motors of 700 hp each the air-gap for each of two is said to be only 3/32 in., and the air-gap for each of four only 0.0825 in. from iron to iron. Each of these seven motors is direct-connected to a continuous-current generator that supplies the street railway system at about 550 volts.

The plant of the Dominion Cotton Mills Company is probably one of the largest of its kind that draws its power from a public system of electrical supply. In these cotton mills the total number of electric motors is 27, and their combined rating amounts to 3,412 hp, divided as follows: Number of motors, 5 of 300 hp each, 1 of 240 hp, 5 of 200 hp, 1 of 150 hp, 2 of 100 hp, 2 of 75 hp, 1 of 50 hp, 1 of 30 hp, 1 of 20 hp, 2 of 15 hp, 2 of 10 hp, 1 of 7 hp, 3 of 5 hp. All of these motors in the cotton mills are of the induction type, save one of 200-hp capacity, which is synchronous. The fact that the Montreal electrical supply system is able to furnish power for this great manufacturing plant on terms that make it unprofitable for the latter to operate with steam is a striking illustration of the advantages of transmitted water power.

Of the 2,161 service transformers used for lighting service on the Montreal system, 1,068 are of less than 5-kw capacity each, 314 have an individual rating of just 5 kw, and 779 transformers are rated at 7½ to 60 kw each. All of these lighting transformers have a combined rating of 13,249 kw, and of this total the transformers of less than 5 kw each represent 2,222½ kw, the transformers of just 5 kw each 1,570 kw, and those of more than 5 kw each an aggregate of 8,930-kw capacity. Of the 695 transformers used for power service, 273 are rated at less than 5 kw each, 98 transformers have just this individual capacity, and 324 transformers are of larger sizes up to 170 kw. The combined rating of 6,980 kw in these transformers used for power purposes is divided into 620 kw for those of less than 5 kw each, 490 kw for those of just 5 kw rating, and 5,867½-kw capacity in transformers that range from 7½ to 170 kw each.

Comparing the lighting and the power transformers it appears that the average rating of all the former is 6.1 kw, and of all the latter 10.0. Of the aggregate rating of 13,249 kw for all lighting transformers, 67 per cent. is in units of more than 5-kw capacity each, while of the 6,980 kw of total capacity in power transformers 85 per cent. is represented by those of more than 5 kw each. These figures bring out one desirable feature of a motor load, namely, that the transformers required for its operation are usually of larger average capacity and consequently of higher efficiency than those used for lighting. Of course, large motors of 100 or more horse-power each have the further advantage that they may take current directly from the distribution lines, and thus require no service transformers whatever.

More Tunnel Traction for New York.

The New York Rapid Transit Commission has granted a franchise to the Hudson & Manhattan Railroad Company to run a tunnel under the North River from Exchange Place, Jersey City, to Cortlandt Street, Manhattan. William G. McAdoo is the president of the company and also is president of the New York & New Jersey Railroad Company, which has received a franchise to run a tunnel under the North River, entering Manhattan at the foot of Christopher Street. The tunnel which will enter the city at Cortlandt Street will run to Church Street and then will form a loop, running back through Fulton Street to the place where the tunnel strikes Manhattan. There will be a spur from the station in Church Street, and this spur will connect at Broadway and Dey Street with the lower Broadway spur of the rapid transit subway.

When the franchise was brought up before the Rapid Transit Commission at last week's meeting, Mayor Low made the point that last summer he had insisted on a change in the grant so as to prevent the corporation from merging with any other company. The attorneys for the tunnel projectors had declined to accept any such condition, and Edward M. Shepard, counsel for the commission, together with Corporation Counsel Rives, had prepared an amendment which was suggested as a general compromise between the position taken by the Mayor and that taken by the company. This was to the effect that, in the event of a merger between the tunnel company and any other concern, both merging companies should agree to carry out all of the obligations of both companies. To this the Mayor consented. The franchise gives to the company a 25-year grant with the privilege of two renewals, one at ten and the other at fifteen years, at varying rates of compensation, equivalent to the city of 3 per cent. of the capital involved and of the earnings of the company as estimated.

Chicago Electrical Association.

A meeting was held at the Lewis Institute on November 20. Before a large audience Professor John D. Nies described split-phase power measurements on alternating circuits. The three-voltmeter method of measuring power in an inductive circuit was described in detail and demonstrated. This, as is well known, consists simply in a method of separating a given impedance into its components, resistance and reactance. The actual power, of course, is then readily found by multiplying the square of the current by the resistance thus found.

Methods of Signaling and Operating in Telephone Exchanges—I.

By Kempster B. Miller and Charles S. Winston.

THE importance of deciding at the outset on the best methods of signaling and operating in telephone exchanges cannot be overestimated. It affects the quality of service given throughout the whole life of the exchange, and therefore the popularity of the enterprise; it affects the cost of operation and therefore the revenue of the company; and it also very materially affects the original cost of the installation, including the switchboard apparatus, the buildings it occupies and the wire plant.

Given a certain definite thing to accomplish, in the way of conveying automatic signals in a telephone exchange, the circuit man will always rise to the occasion, usually with more than one way of accomplishing it. The manner in which the signals between the various persons concerned in different parts of the exchange may best be conveyed and interpreted is, as a rule, more difficult of solution than the designing of the circuit after the method has once been decided on. It is a question in which the personal equation of both operator and subscriber enters to a large extent; and this fact alone makes it solvable by long experience and study, rather than by pure reasoning power alone.

Primarily, the question involved is "what does the subscriber want?" and this rather than what the electrical engineer says "he ought to want," should form the basis of future work. The work of determining what the subscriber, using the word collectively, actually does want has been and probably always will be difficult. This should devolve on the "traffic engineer," if we may use the term, who in turn should require of the electrical engineer a system which with due regard to effectiveness and to economy of operation, and of first cost will come nearest to the ideal set by the demands of the subscribers.

The question resolves itself into two important factors. First, the giving of the best possible service to the community; and second, the working of the apparatus, the plant and the operators, to the best advantage from an economical standpoint.

Much has been written concerning the circuits employed in nearly all branches of telephone service, but few articles have appeared on the methods of signaling and operating, dealing with the general problem of the functions which the circuits should perform. There has been as much diversity as to what should constitute a proper code of signaling in the various branches of telephone service; that is, as to the manner in which the signals should be communicated to, and interpreted by the various persons concerned in making a connection, as there has been in regard to the actual circuits for accomplishing such ends when once determined on. Experience alone has taught what is best, and it is only in recent years that practice has become fairly well standardized. It is the purpose of this article to show what some of these standards are and why they are, regardless, as far as possible, of any circuit arrangement.

In the modern forms of magneto systems still widely used in small exchanges, the operator can depend only partially on signals, and must rely for obtaining much of the information as to the conditions of a connection, by frequently listening in on the circuit for verbal communications with the connected subscribers or with other operators. What signals are transmitted by the subscriber are done by some voluntary act on his part, which he is liable to do improperly, or to forget altogether, so that the magneto system is much more dependent on the untrained human element than it should be.

To make this more clear, reference is made to Fig. 1, which represents the essential elements of a connection between two subscribers' stations equipped with magneto instruments. In order to call the central office, subscriber *A* turns his generator crank, which displays at the central office a signal in the form of a shutter, belonging to the annunciator corresponding to that line. If the subscriber is a novice, he may first remove his receiver from the hook, which may or may not prevent his sending any signal at all. Thus the very act of the subscriber's attempting to originate a call is dependent on his performing certain acts in a definite order, none of them being in any sense automatic. The operator seeing the signal, inserts an answering plug, and by means of a key listens in to ascertain the number of the subscriber desired, after which she completes the connection by inserting her calling plug into the jack of the subscriber called for (subscriber *B*), and by means of her ringing key calls him. She has no means of knowing when subscriber *B* responds, or when subscriber *A* gets tired of waiting and hangs up his receiver, other than by frequently listening in on the circuit to hear or inquire whether the conversation is in progress.

When the subscribers have finished their conversation, one or both of them may remember to operate their generators, and thus throw the clearing-out signal associated with the cords as a disconnect signal for the operator. As is well known, they frequently neglect this, in which case the operator can only ascertain by inquiry. Again, the display of the clearing-out signal conveys no definite information to the operator, as it may mean one of several things: Both subscribers may desire a disconnection, one subscriber may desire another connection, one or both may desire the attention of the operator, or it may mean that one of the subscribers has attempted to ring the other subscriber direct. In any event, the operator must listen in on the circuit to know how to interpret the signal. All this requires time and necessitates the tieing up of the apparatus for a longer time than is actually necessary. Besides this, the constant listening in of the operator is a disagreeable feature to the subscriber, and destroys all idea of secrecy on his part.

One of the many and also one of the most important advantages in common battery systems which are now rapidly supplanting the magneto, is the fact that at all times after a connection has been established it is possible for either subscriber to attract the attention of some operator, and the operator who has charge of the connection knows at all times the exact conditions on the lines; that is, she knows whether the called subscriber has answered the call, or whether the calling subscriber is waiting for the connection to be established, whether conversation is finished, and at the end of the conversation whether either subscriber desires her attention for making another connection or for any other purpose.

The common battery system naturally lends itself to automatic signaling because, all sources of electrical energy being at the central office and ready for service on every line, it remains only for the subscriber to close the circuit to draw on the energy or to open the circuit to shut it off. These acts on the subscriber's part are performed without his volition, inasmuch as they are made accessory to some other act which he must perform in order to use the instrument.

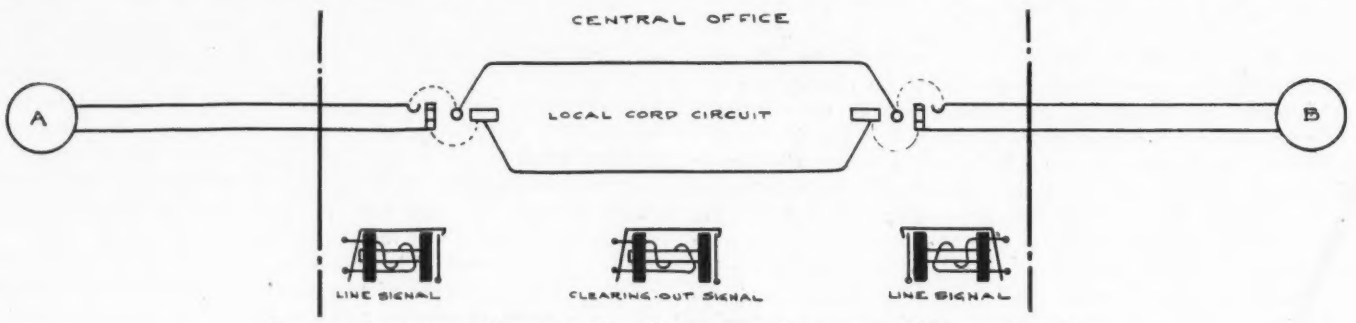


Fig. 1.—Connection Between Two Subscribers Through a Magneto Office.

The whole tendency of telephonic development has been to simplify the work of the subscriber by giving him nothing to do further than placing the receiver at his ear and asking for what he wants. This tendency has gone hand in hand with the simplification of the subscriber's apparatus, and these two facts have led to the doing away with the magneto generator and local battery, thus reducing the apparatus at the subscriber's station to the fewest possible elemental parts.

In the signaling from the subscriber to the general office and between the various operators at the exchanges, the tendency has been, and is constantly growing, to have every signal automatically

sent, and to mean positively one thing and one thing only. Each operator is made a specialist, performing one class of work only, and no matter what the requirements on her may be, she is always to interpret each signal in a certain inflexible way. In this connection it may be said that we believe that those in charge of large exchanges who are loading their regular operators up with various classes of special work, are making a grave mistake; and further, that any tendency in the development of telephony which tends to increase the complexity of the subscriber's instrument, or to throw an additional amount of work on the subscriber, is taking a decided step backward.

Before going further, to avoid confusion, we will define what we believe to be the proper meanings of two much-abused terms in telephony—"telephone office" and "telephone exchange."

A telephone office is an establishment in which telephone lines

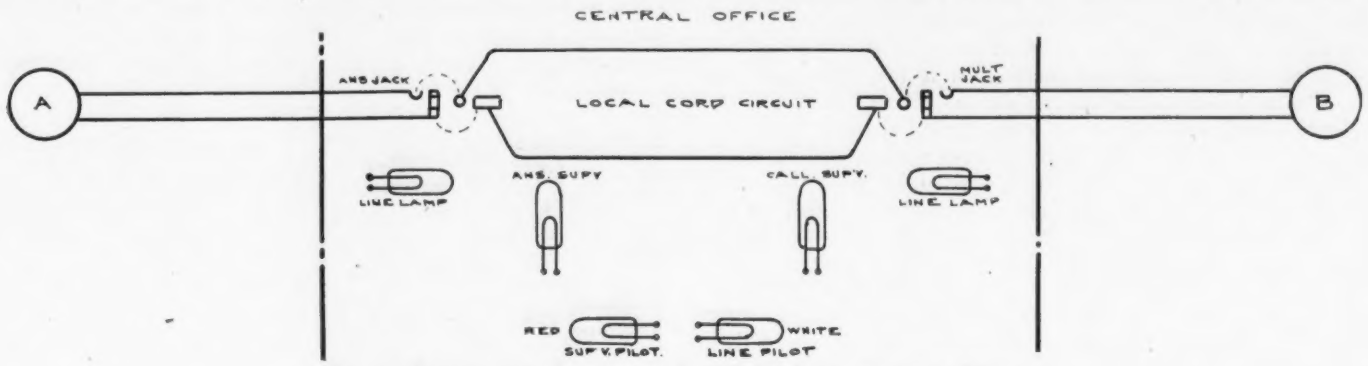


FIG. 2.—CONNECTION THROUGH A SINGLE COMMON BATTERY OFFICE.

center, containing equipment for interconnecting the lines for conversation in accordance with the demands of the subscribers served by them.

A telephone exchange is an organization of one or more telephone offices, with their extending lines and substation apparatuses for supplying telephone service to a given community.

In discussing the methods of operation in common battery exchanges it will be necessary to classify service under several headings, on account of the large number of kinds of service that are required, owing to the existence of one or more offices in the same city, of toll connections, private branch boards, measured service, etc. In the accompanying figures *A* always represents the station of the calling subscriber, and *B* that of the called.

I. CONNECTION BETWEEN TWO SUBSCRIBERS IN THE SAME COMMON BATTERY OFFICE.

When a subscriber desires to converse with a second subscriber in the same office, he will remove his telephone from its hook, and thus light the line lamp (Fig. 2) associated with his line at the multiple switchboard. In order to assist the operator it is customary to locate at each position a pilot lamp, which lights whenever any line lamp at her particular position lights. The operator noting that this pilot lamp is lighted, inserts the answering plug of one of her cord circuits into the answering jack immediately above the line lamp, which lighted at the same time. This act will extinguish both the line and the pilot lamps, putting the line lamp out of service and leaving the pilot lamp ready to assist in attracting the attention of the operator to another call on some other line. The operator will then throw the listening key, and having found out from the calling subscriber the number of the line with which connection is desired, will test the multiple jack of this line with the calling plug associated with the answering plug in use, and in case the line is busy, she will tell the calling subscriber and pull down the connection. If, however, the line called for is clear, the operator will insert the plug into the multiple jack and ring.

Associated with each plug of a cord circuit is a supervisory lamp, each of which is under the exclusive control of the subscriber with whose line the corresponding plug is connected, this control being affected by the position of the subscriber's switch hook. When the operator inserted the answering plug into the answering jack of the calling subscriber, the supervisory lamp associated with that plug remained unlighted, because the subscriber's receiver remained off its hook. As soon, however, as the calling plug has been inserted into the jack of the called line, the supervisory lamp associated with that play will light and will remain lighted until the called-for subscriber responds to the call by taking his receiver from its hook, when the lamp will be extinguished, thus indicating to the operator that a response has been made and that the conversation is in progress. Both supervisory lamps will remain unlighted until the end of conversation, when both subscribers will hang up their receivers and thus light the answering and calling supervisory lamps associated with the cord circuit which has been used for the connection, which is a positive signal to the operator for disconnection.

It is customary practice for many independent companies to locate at each position a supervisory pilot lamp which will light whenever the answering supervisory lamp of any cord at that position is lighted. As the cord circuits of the Western Electric Company cannot be provided with this feature without many complications, Bell companies do not provide this pilot lamp.

The wire which carries battery for all of the line and supervisory pilot lamps in an office is ordinarily carried through the winding of a relay which is so wired that when operated it causes a bell or buzzer to ring, whenever a switch, which controls it, is thrown to the proper position. This bell or buzzer is intended to be used as a night alarm, and is not left in circuit during the day time. With this arrangement, at night or during the least busy hours of the day, one or a few operators may handle the entire office, the operator's attention being attracted to a call on any part of the board by the sound of the night alarm. A glance along the board will then show her at which position a pilot lamp is lighted, and on reaching that position the line lamp will show which particular line needs attention.

In case the exchange has party lines with selective signals, some means should be provided by which the operator will know which party she has rung last. If an indicating scheme is not provided, it is often necessary for the operator to ask the calling subscriber to repeat the number of the line which he has previously called for, an undesirable thing, because the subscriber may have forgotten the number, having once told it to the operator. Even if the subscriber has not forgotten the number, he does not understand why it has been necessary for the operator to again request the number, and is apt to attribute it to carelessness or incompetence.

The best practice to-day, where selective signaling party lines are used in considerable numbers, seems to be to equip each pair of cords in the entire office with party-line ringing keys, each key being provided with an indicator to show which of the several selective ringing currents had been last sent to the line by that particular key. With this arrangement, an operator noticing (by the calling supervisory) that a called party has not responded, has only to repeat the same ringing operation which the indicator on that ringing key shows her was last made.

In some cases, instead of supplying each pair of cords with a complete selective ringing key, a master key is provided on each position, which when operated determines the selective ringing current which the individual ringing key on each cord will send to the line. Although these master keys are sometimes provided with indicators, this practice is faulty because while the indicator may show what selective current was last used on that position, it does not show what pair of cords it was used on, and the operator is little better off than without it. This plan has only cheapness to recommend it.

For some unknown reason there are some multiple switchboards in use and others are now being constructed wherein the answering jacks are placed in a bank just above the plug shelf, while the corresponding line lamps are placed in a separate bank above them. This practice is to be strongly condemned from an operating standpoint, as by it one of the chief advantages of the lamp signal is lost, *i. e.*, the placing of the signal for each line immediately adjacent to the answering jack belonging to that line, so that the operator may plug

into the proper jack in response to a call without once removing her gaze from the displayed signal or bothering her head about the number of the calling line. There are no apparent structural advantages to warrant this sacrifice in operating speed.

Work of the Motorman on the Zossen Car.

Further details were given, with illustrations, in our last issue as to the recent high-speed work on the electric road at Zossen, and we are now able to present a view of the interior of the motorman's cab of the Siemens & Halske car. From a first glance it might appear that a motorman with the multiple limbs of an octopus, the eyes of an argus, and the speed of a whip snake would be needed to watch and look after all these indicators, controllers, levers, brake handles, etc., but as a matter of fact the car lends itself to easy control and no difficulty worth mention is found in operating it by the "man at the helm." As to the cars themselves, it may be noted that certain changes were made in the motor wiring on the Allgemeine car. At first all the motors were started simultaneously, but later the stator windings of the four motors were placed in circuit one after the other, the motors being started by gradually short-circuiting the rotor windings. This arrangement avoided an unnecessarily heavy current intake at starting and also permitted the cutting out of the stators of one or more motors after normal speed had been attained and only two or three motors were required to continue running the car at the same speed. Although these motors were rated at 250 hp they carried 750 hp each at starting without rising more than 20° C. because the motors were cooled by compressed air.

The apparatus used during the trial runs is shown in the general view of the Siemens-Halske cab and consists of the following: *A*

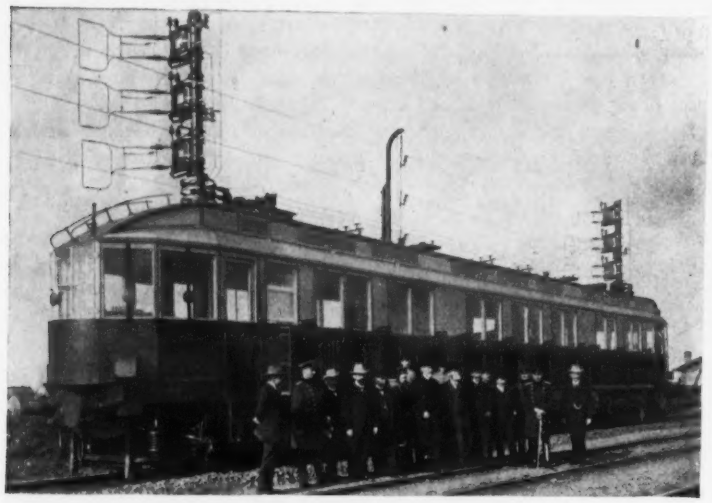


FIG. 1.—CAR AND THOSE CONDUCTING TESTS.

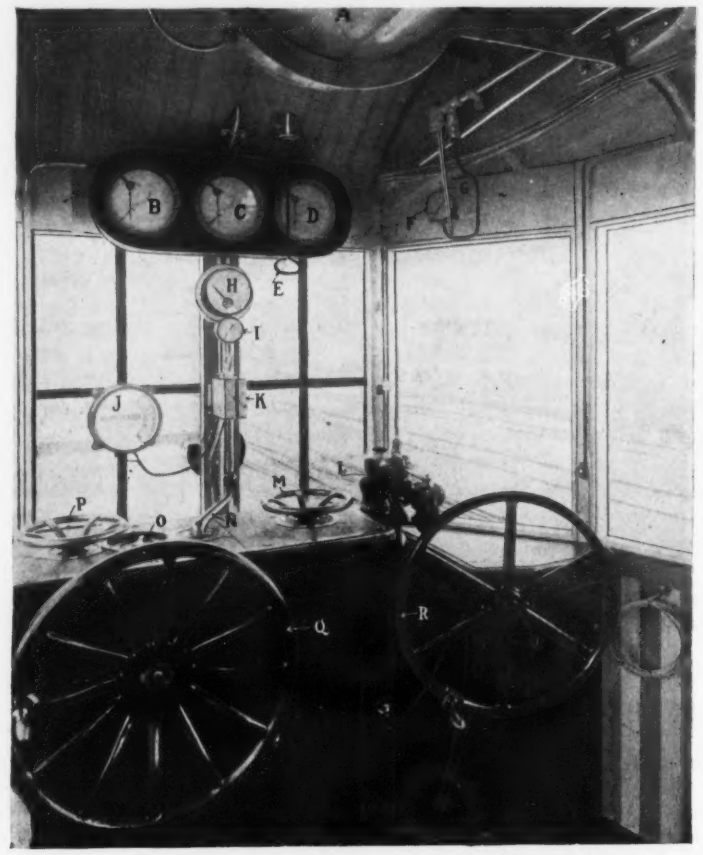


FIG. 2.—INTERIOR OF MOTORMAN'S CAB.

is the principal compressed air reservoir for operating all of the apparatus; *B* and *C* are ammeters for truck No. 1 and truck No. 2, respectively; *D* is the line voltmeter; *E* is the handle for the air whistle; *F* is the pressure gate; *G* is the acceleration indicator; *H* is the pressure gauge for the brake cylinder; *I* is the pressure gauge for the train line pipe; *J* is the speed indicator; *K* is the switch for connecting up the speed indicator according to the direction of running; *L* is the Westinghouse air brake valve; *M* is the motor switch; *N* is the controller switch; *O* is the rheostat indicator; *P* is the air compressor switch; *Q* is the starting rheostat, and *R* the hand brake wheel.

To enable all readings to be made simultaneously a clock was used which rang a bell twice every 10 seconds, the instruments being read immediately after the second ringing. The speed was measured in several ways. One of the methods included the use of a precision voltmeter which indicated the voltage of a small direct-current generator coupled to a car axle and also had a scale divided into kilometer-hours. Besides a number of mechanical speed indicators, the Siemens-Halske Company used a graphic recording instrument, which made three different records. Each pencil was operated by an electromagnet and the recording paper strip by clockwork. One of the pencils punched a hole along one part of the strip every second; the second pencil was actuated by a current flowing through a battery and the free middle axle of one of the trucks, one perforation being made for every revolution of the axle; the third pencil perforated the paper every time a kilometer mark was passed, this being accomplished electrically by having a small contact brush strike iron projections placed near the track and spaced one kilometer apart.

To determine the air pressure several openings were made in the walls of each car, each opening being connected with a U-shaped glass tube partly filled with water and graduated to millimeters. The pressure was, therefore, measured by noting the change in the height of the water columns in the branches of each tube.

The acceleration was determined according to the method suggested by Kapp. A vertical glass tube was placed at each motorman's stand, both tubes being connected by a pipe running through the car floor parallel to the rails. The tubes were filled to a certain height with colored water. When the car started the liquid in the front tube began to fall while that in the rear tube rose. The acceleration was determined by measuring the distance between the tubes and the difference in height of the water columns.

Another interesting device used was an automatic brake pressure regulator, combined with a speed indicator, which served to keep the brake pressure proportional to the retardation desired. Several instruments were also used for measuring the torque of the motors and the swaying of the car.

Chicago Municipal Lighting.

Mayor Carter Harrison, of Chicago, has recently declared that the city of Chicago will enter the electric lighting field at once in competition with the gas and electric companies. The attempt to enter the field by selling to corporations and private individuals electric current made in the municipal plants, it is expected, will result in an appeal to the courts by the big lighting corporations. This, Mayor Harrison declares, is what the city would invite, as it will determine its right to deal in public necessities. "It is just as well to meet this matter at once," said Mayor Harrison. "The earlier we enter the field the earlier we will be prepared to take advantage of the development of the power at the mouth of the great drainage channel connecting the waters of Lake Michigan and the Mississippi River."

Calculation of the Apparent Inductance of Armature Coils.—IV.

BY C. C. HAWKINS.

BY the use of the foregoing rules coupled with the pictures of e.g., Fig. 10, the total value of the sum $b + b' + \ldots$ for the pair of interpolar zones can be calculated for the different kinds of winding, specimens of results being given, Figs. 24 and 29. The process of calculating the surface-of-the-core inductance is by their aid greatly simplified, since by the alteration of the scale of abscissæ they are readily adapted to different numbers of poles and average widths of tooth and slot. Further, although the absolute degree of accuracy that can be claimed may be but small, yet since they are all reduced to a definite basis of procedure they furnish comparative figures for immediate application by the designer to the different kinds of winding, and incidentally serve to bring to light certain interesting points. As a general rule no shorter chord is considered than will give four slots, or in exceptional cases five slots, concerned per interpolar zone. The lower end of each curve indicates the smallest diameter of armature on which the particular winding should be employed when the short-circuited spool sides practically span the entire interpolar zone. If extended to still smaller armatures, the band of spool sides approaches dangerously near to the pole tips even when the angle of lead is zero.

The curves for any given number of spool sides per slot and given value of s show clearly the advantage of separating the short-circuited spool sides among a number of slots as by long and short-chord windings in contrast to diametric. As more slots are brought into action by spreading out the wires, the local flux surrounding the considered section is in many cases reduced, and the joint flux due to all the short-circuited spool sides is as it were driven further outwards towards the pole tips. At the pole tips and beyond them the variations of the flux are *ex-hypothesi* damped out, so that the inductance from the joint flux is reduced; but the advantage is gradually reduced with a given width of tooth and slot as the diameter of the armature is increased. With small armatures when the wires

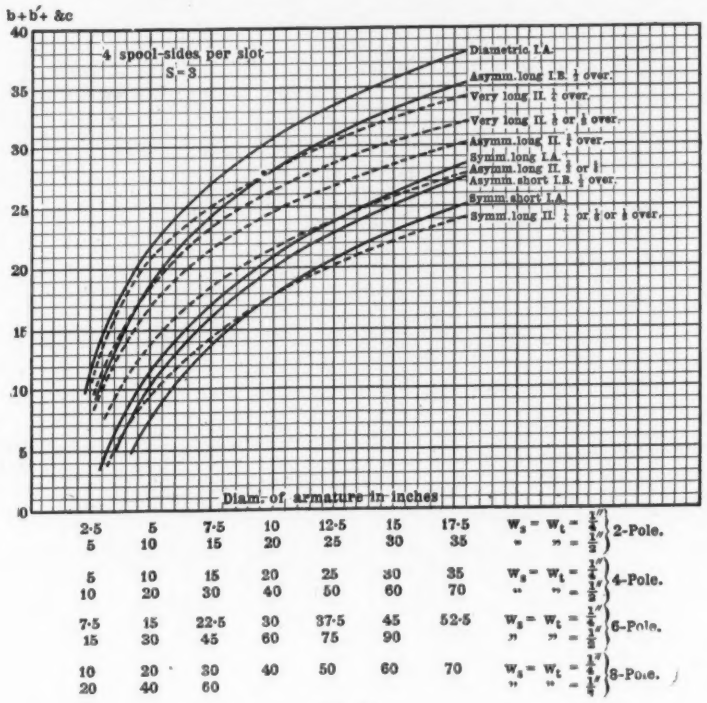

b+b'+ &c
4 spool-sides per slot
S = 3
Diametric I.A.
Asymm. long I.B. ½ over.
Very long II. ½ over.
Very long II. ⅔ or ⅓ over.
Asymm. long II. ⅔ over.
Symm. long I.A.
Asymm. long II. ⅔ or ⅓
Asymm. short I.B. ½ over.
Symm. short I.A.
Symm. long II. ⅔ or ⅓ or ⅓ over.
Diam. of armature in inches
2·5 5 7·5 10 12·5 15 17·5 $W_s = W_t = \frac{1}{4}''$ 2-Pole.
5 10 15 20 25 30 35 " " = $\frac{1}{2}''$
5 10 15 20 25 30 35 $W_s = W_t = \frac{1}{4}''$ 4-Pole.
10 20 30 40 50 60 70 " " = $\frac{1}{2}''$
7·5 15 22·5 30 37·5 45 52·5 $W_s = W_t = \frac{1}{4}''$ 6-Pole.
15 30 45 60 75 90 " " = $\frac{1}{2}''$
10 20 30 40 50 60 70 $W_s = W_t = \frac{1}{4}''$ 8-Pole.
20 40 60 " " = $\frac{1}{2}''$

FIG. 24.

are spread out, the apparent inductance is very much reduced from its value for the diametric case, but with larger armatures the influence of the joint flux becomes more and more predominant, and when the area which it traverses becomes large as compared with that of the local flux the reduction for any given degree of chord is much less marked. Naturally, too, the change from long to short chord produces nothing like the same proportionate reduction as the change from diametric to long chord.

The general tendency of the fractional cases is also well shown by the dotted curves as compared with the full-line curves. Whenever with a given value for s the total number of short-circuited spool sides in a pair of interpolar zones is reduced by one or two, as compared with the number for whole values of $\frac{N_2}{2p}$, then for the windings which are most closely analogous the fractional curves bend over and become flatter. This is simply due to the fact that the local flux remains more or less the same, but the joint flux is

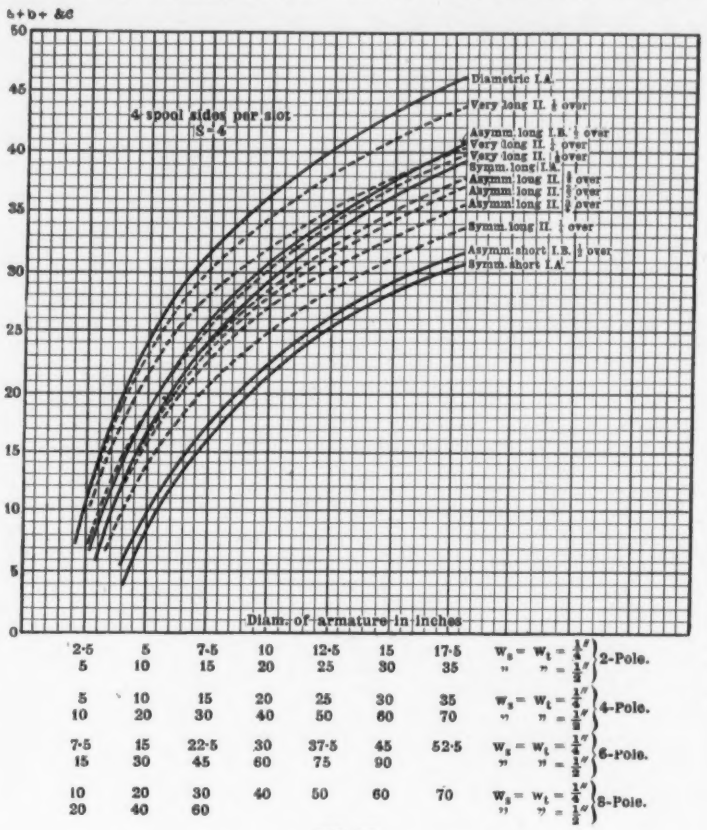

b+b+ &c
4 spool sides per slot
S = 4
Diametric I.A.
Very long II. ½ over
Asymm. long I.B. ½ over
Very long II. ⅔ over
Very long II. ⅓ over
Symm. long I.A.
Asymm. long II. ⅔ over
Asymm. long II. ⅔ over
Asymm. long II. ⅓ over
Symm. long II. ½ over
Asymm. short I.B. ½ over
Symm. short I.A.
Diam. of armature in inches
2·5 5 7·5 10 12·5 15 17·5 $W_s = W_t = \frac{1}{4}''$ 2-Pole.
5 10 15 20 25 30 35 " " = $\frac{1}{2}''$
5 10 15 20 25 30 35 $W_s = W_t = \frac{1}{4}''$ 4-Pole.
10 20 30 40 50 60 70 " " = $\frac{1}{2}''$
7·5 15 22·5 30 37·5 45 52·5 $W_s = W_t = \frac{1}{4}''$ 6-Pole.
15 30 45 60 75 90 " " = $\frac{1}{2}''$
10 20 30 40 50 60 70 $W_s = W_t = \frac{1}{4}''$ 8-Pole.
20 40 60 " " = $\frac{1}{2}''$

FIG. 25.

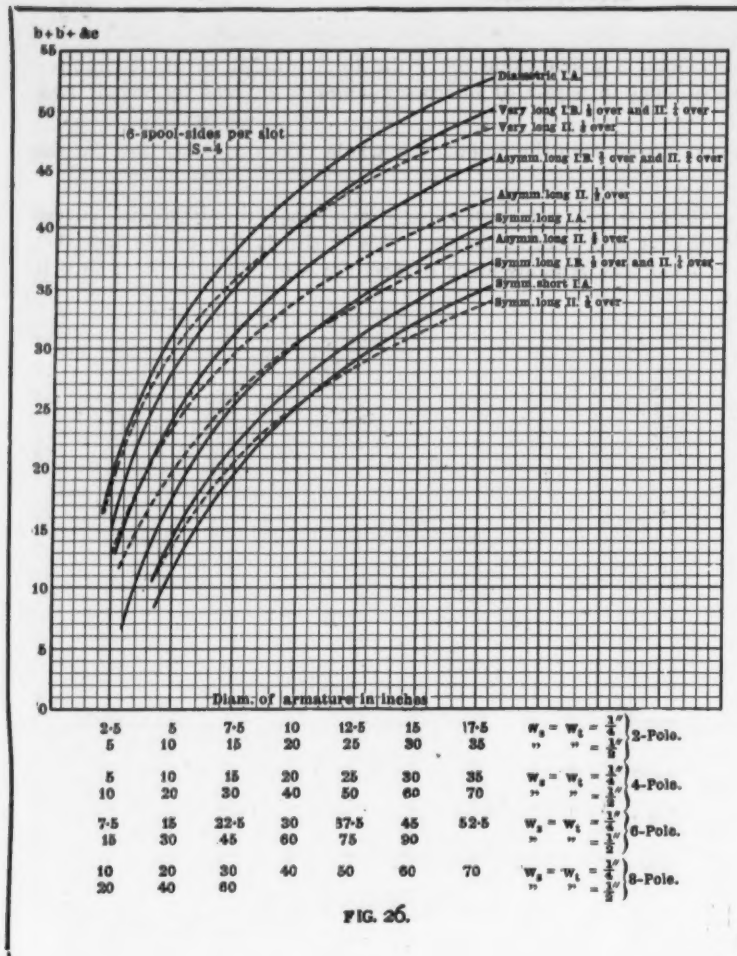
positively reduced, and this has the preponderating effect in armatures of large diameter. It should be noticed that with fractional windings and taking only a pair of interpolar zones, there may be $2s$ or $(2s - 1)$ short-circuited spool sides in a zone, and that it is by no means necessary for the number to be alike in the adjacent pair of zones. But it will also be seen that when the number of spool sides per slot is large and s is also large, the divergence of the fractional from the analogous whole cases becomes less and less, since obviously the addition or subtraction of two spool sides from a comparatively large number has no great effect. Practically, therefore, so far as $L + \Sigma M$ is concerned, when s is fairly large there is but little difference between fractional or whole windings, and any advantage that may be claimed for the former must be based solely on considerations of Ls, which has yet to be discussed.

If for the same number of spool sides per slot and for the same class of winding, the curves for different values of s are plotted together, as in Fig. 30, it will be seen that as the band of short-circuited wires increases with increasing values of s, the rise of the surface-of-the-core inductance is never in proportion to the increase of s when once $s > \frac{kn}{2}$, but is more nearly so on large armatures, where the joint flux plays the most important part. As the adjacent slots become more balanced, the local flux decreases, and the rise is but slight, if the armature be of small diameter. Thus the curves cross one another higher and higher up as the influence of the joint flux reasserts itself on armatures of large diameter.

7. *Calculation of inductance of end connections.*

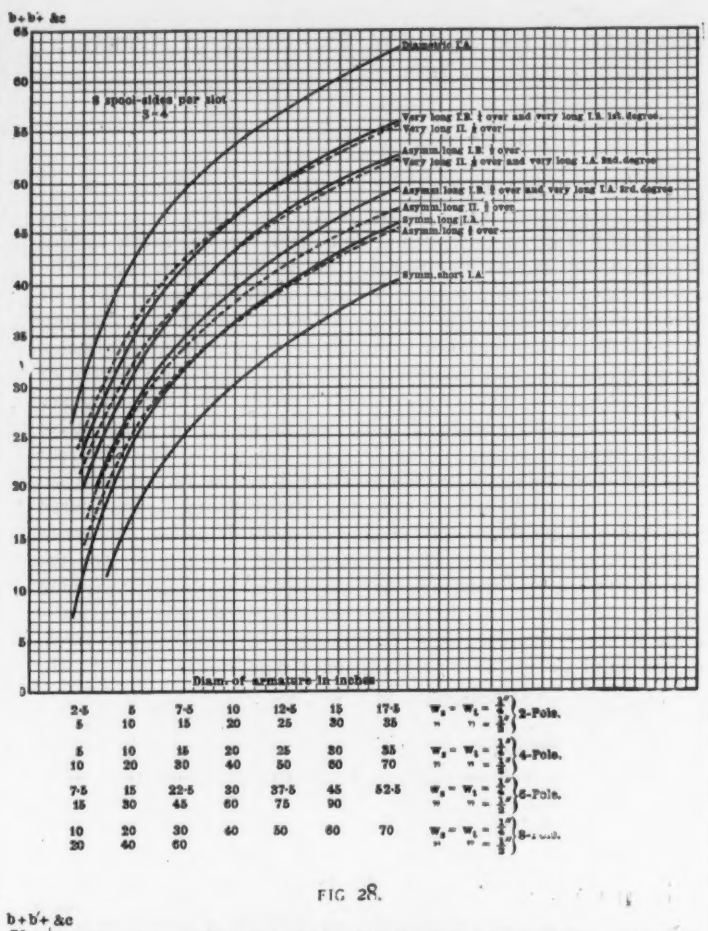
The self and mutual inductance of the end connections can be calculated after the method employed by Prof. Arnold.§ If s sections are simultaneously short-circuited at one brush, their end connections run side by side; let d_s = the diameter of a circle whose

§ Die Gleichstrommaschine, vol. i, p. 332.


b+b'+ &c
6-spool-sides per slot
S=5
Diametric I.A.
Very long I.B. ⅘ over and II. ⅗ over
Very long II. ⅘ over
Asymm. long I.B. ⅘ over and II. ⅘ over
Asymm. long II. ⅘ over
Symm. long I.A.
Asymm. long II. ⅗ over
Symm. long I.B. ⅘ over and II. ⅗ over
Symm. short I.A.
Symm. long II. ⅗ over
Diam. of armature in inches

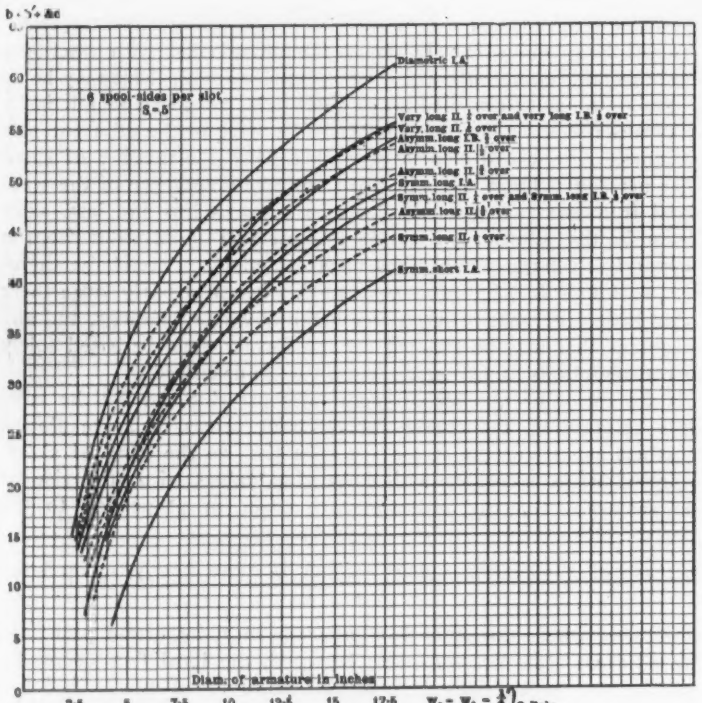
2·5	5	7·5	10	12·5	15	17·5	$W_s = W_t = \frac{1}{4}''$
5	10	15	20	25	30	35	" " $= \frac{1}{2}''$ } 2-Pole.
5	10	15	20	25	30	35	$W_s = W_t = \frac{1}{4}''$
10	20	30	40	50	60	70	" " $= \frac{1}{2}''$ } 4-Pole.
7·5	15	22·5	30	37·5	45	52·5	$W_s = W_t = \frac{1}{4}''$
15	30	45	60	75	90		" " $= \frac{1}{2}''$ } 6-Pole.
10	20	30	40	50	60	70	$W_s = W_t = \frac{1}{4}''$
20	40	60					" " $= \frac{1}{2}''$ } 8-Pole.

FIG. 26.


b+b'+ &c
8 spool-sides per slot
S=5
Diametric I.A.
Very long I.B. ⅘ over and very long I.B. 1st. degree
Very long II. ⅘ over
Asymm. long I.B. ⅘ over
Very long II. ⅘ over and very long I.A. 2nd. degree
Asymm. long I.B. ⅘ over and very long I.A. 3rd. degree
Asymm. long II. ⅘ over
Symm. long I.A.
Asymm. long II. ⅗ over
Symm. short I.A.
Diam. of armature in inches

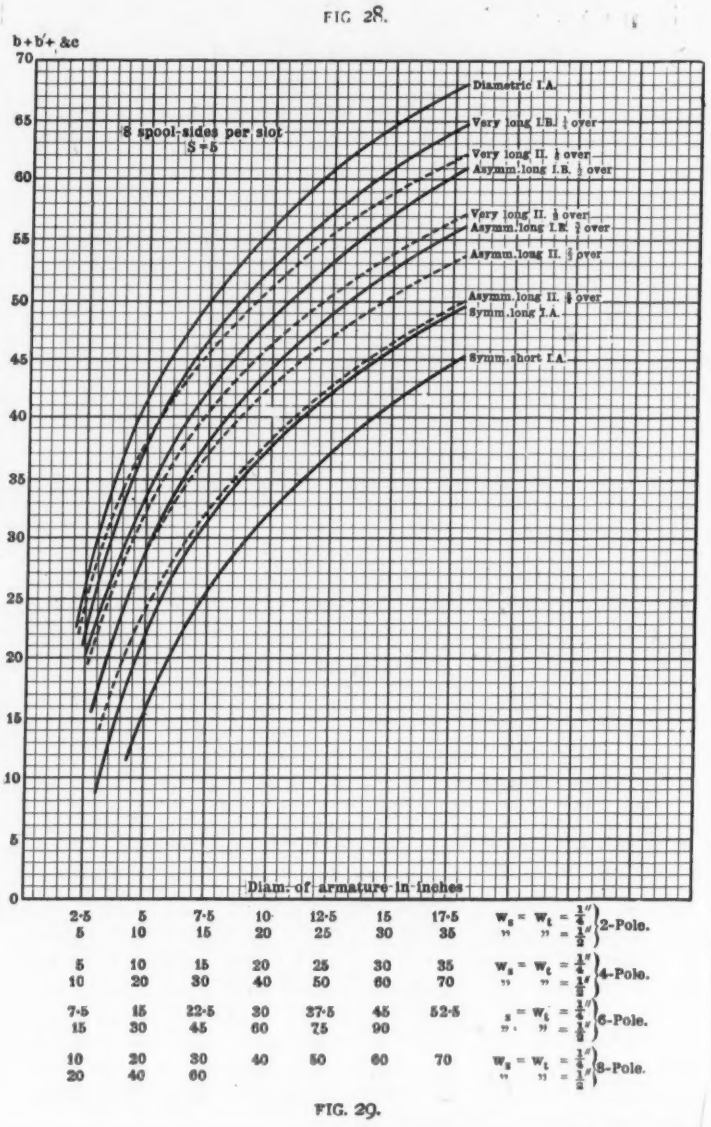
2·5	5	7·5	10	12·5	15	17·5	$W_s = W_t = \frac{1}{4}''$
5	10	15	20	25	30	35	" " $= \frac{1}{2}''$ } 2-Pole.
5	10	15	20	25	30	35	$W_s = W_t = \frac{1}{4}''$
10	20	30	40	50	60	70	" " $= \frac{1}{2}''$ } 4-Pole.
7·5	15	22·5	30	37·5	45	52·5	$W_s = W_t = \frac{1}{4}''$
15	30	45	60	75	90		" " $= \frac{1}{2}''$ } 6-Pole.
10	20	30	40	50	60	70	$W_s = W_t = \frac{1}{4}''$
20	40	60					" " $= \frac{1}{2}''$ } 8-Pole.

FIG. 28.


b+b'+ &c
8 spool-sides per slot
S=5
Diametric I.A.
Very long II. ⅘ over and very long I.B. ⅘ over
Very long II. ⅘ over
Asymm. long I.B. ⅘ over
Very long II. ⅗ over
Asymm. long I.B. ⅗ over
Asymm. long II. ⅘ over
Symm. long I.A.
Symm. long II. ⅘ over and Symm. long I.B. ⅗ over
Asymm. long II. ⅗ over
Symm. long II. ⅗ over
Symm. short I.A.
Diam. of armature in inches

2·5	5	7·5	10	12·5	15	17·5	$W_s = W_t = \frac{1}{4}''$
5	10	15	20	25	30	35	" " $= \frac{1}{2}''$ } 2-Pole.
5	10	15	20	25	30	35	$W_s = W_t = \frac{1}{4}''$
10	20	30	40	50	60	70	" " $= \frac{1}{2}''$ } 4-Pole.
7·5	15	22·5	30	37·5	45	52·5	$W_s = W_t = \frac{1}{4}''$
15	30	45	60	75	90		" " $= \frac{1}{2}''$ } 6-Pole.
10	20	30	40	50	60	70	$W_s = W_t = \frac{1}{4}''$
20	40	60					" " $= \frac{1}{2}''$ } 8-Pole.

FIG. 27.



2·5	5	7·5	10	12·5	15	17·5	$W_s = W_t = \frac{1}{4}''$
5	10	15	20	25	30	35	" " $= \frac{1}{2}''$ } 2-Pole.
5	10	15	20	25	30	35	$W_s = W_t = \frac{1}{4}''$
10	20	30	40	50	60	70	" " $= \frac{1}{2}''$ } 4-Pole.
7·5	15	22·5	30	37·5	45	52·5	$W_s = W_t = \frac{1}{4}''$
15	30	45	60	75	90		" " $= \frac{1}{2}''$ } 6-Pole.
10	20	30	40	50	60	70	$W_s = W_t = \frac{1}{4}''$
20	40	60					" " $= \frac{1}{2}''$ } 8-Pole.

FIG. 29.

periphery is equal to that of the group of s spool ends, inclusive of insulation and any air-gaps which there may be between them, as in Fig. 31, where the periphery of the dotted circle is equal to the periphery of the rectangular packet of three spool ends, each containing four wires. The two V-shaped sets of end connections, one at either end of a barrel-wound drum armature and each of length l' cm., may be replaced by an equivalent circle of radius, $r = \frac{l'}{\pi}$ (Fig. 32). The permeance of a circle of air round the end connections of width dx (Fig. 33) is $\frac{l'\,dx}{2\pi\,x} \times 2$, and this is acted on by a m.m.f. of $4\pi\,w\,s$, where w is the number of wires in one spool side. An element of the inductance is, therefore, $dL = \frac{4\pi\,w^2\,s\,l'\,dx}{\pi x}$ and the integral of $\frac{dx}{x}$ between the limits of the radius, r, of the complete circle and the radius $\frac{ds}{2}$ of the small equivalent circle, or

$$\int_{ds/2}^{l'/\pi} \frac{dx}{x} = \log \frac{l'}{\pi} - \log_e \frac{ds}{2}$$

Since $w = \frac{\tau}{2N_2}$, the coefficient for insertion in our chief equation is

$$c = \left(2.3 \log \frac{l'}{ds} - 0.45\right) \times s.$$

8. *The wave-wound armature.*

While in the above the lap-wound armature has been alone considered, the curves being only immediately applicable to wave-wound machines if the armature be two-pole, yet the series-connected wave-wound armature in multipolar fields must also be treated. Here the various interpolar zones are dissimilar to one another, either all or part of them, and, taking first the case when only two sets of brushes are employed, a first approximation will consist in finding the pair of interpolar zones which give the maximum inductance and expressing the total inductance as a certain percentage of this value when multiplied by p. For this percentage the average value is about 90 per cent., but the validity or otherwise of such a figure deserves further examination.

The inductance of the end connections is p times that of a single section when there is only one inductor in each spool side, and is but very slightly less when there are a large number of inductors forming a common spool which is afterwards joined up to the next section by a single connecting wire. On the other hand, the inductance from the slots and from the surface of the core is appreciably reduced below the value of p times the value for a single pair of zones. No one ratio holds even over a small range of cases with great strictness, owing to the divergence in different machines of the relative values for the slot and surface inductances. But apart from this, certain further remarks may be added with special reference to the inductance from the surface of the core. For a given value of s and a fixed number of poles, the percentage is always less in the case of a small armature than in a large armature, since the spreading out of the spool sides has proportionately less effect as the value from the joint flux beyond the limits of the short-circuited wires assumes a preponderating influence. Next as the value of s is increased, the percentage rises since the distribution in the several zones becomes more nearly similar, the presence or absence of certain spool sides having less effect when the total number is large. There is, therefore, no fixed value of the percentage that can be regarded as generally applicable, and it is better to work out once and for all curves for the several cases analogous to Figs. 24 and 29 rather than to rely upon any average results.

When, as many sets of brushes as there are poles are employed, it should be observed that the time during which a section is undergoing short-circuit either at one brush or between two brushes of the same sign is increased. It is best, therefore, to consider a single section between two adjacent brushes of the same sign and when in the position of maximum inductance, and then to take the entire time during which it is undergoing short-circuit, partly as a portion of a zig-zag winding round the whole armature and partly as a single section short-circuited by adjacent brushes of the same sign. If T be the time of short-circuit as ordinarily reckoned from the width of a brush, the general formula for the real time of short-circuit is $T\left(1 + \frac{x}{y}\right)$, where x is the fraction of a sector which results from $\frac{N_2}{p}$, and y is the width of a brush expressed in terms of the width of a sector. Thus with four poles and an armature with every slot equally filled, $\frac{N_2}{p}$ always leaves a remainder $\frac{1}{2} = x$, and if the brush width is equal to the width of one sector, $y = 1$, so that $T' = 1\frac{1}{2}\,T$; but if the brush width is equal to twice the width of

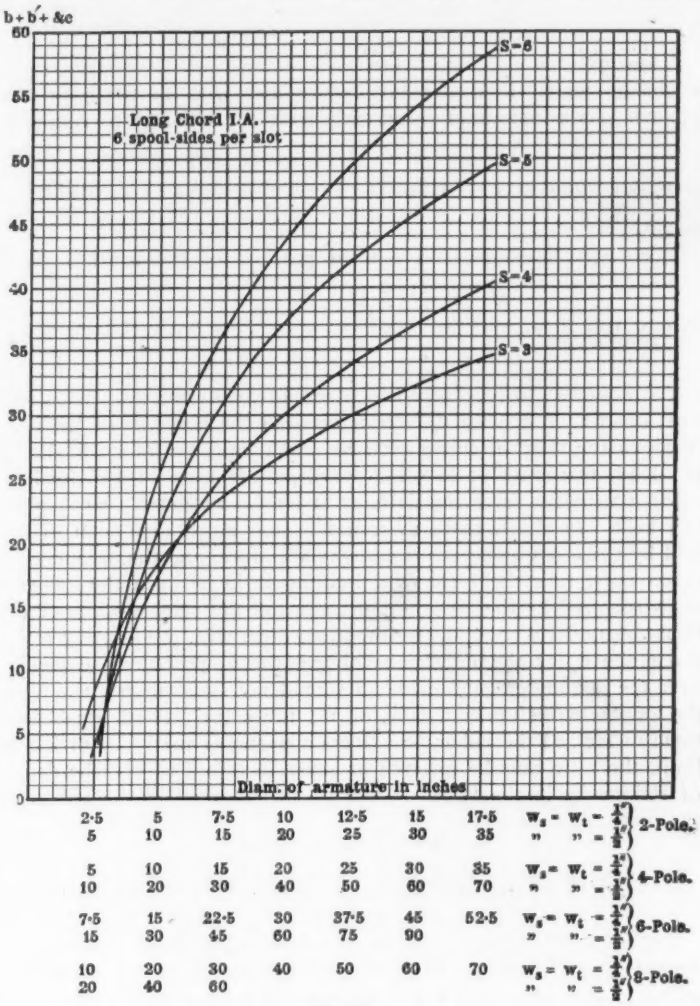


FIG. 30.

a sector, $T' = 1\frac{1}{4}\,T$. With six poles and four spool sides per slot, $\frac{N_2}{p}$ may leave as a remainder either $\frac{1}{3}$ or $\frac{2}{3}$, so that the increased times for the same widths of brush as above are $1\frac{1}{3}\,T$ and $1\frac{2}{3}\,T$ for the narrow brush, or $1\frac{1}{6}\,T$ and $1\frac{1}{3}\,T$ for the wide brush. In every case when the number s is great, so that y is great, the increase of the time is but small; e. g., if $s = 5$, and the brush has a width of $4\frac{1}{2}$ sectors, the increase in the four-pole machine is only some 10 per cent.

9. *Use of $L + \Sigma M$ in practice.*

The practical use of the foregoing calculations may now be summarized by saying that when the value of $\frac{2J\,(L + \Sigma\,M)}{T}$ is thence

deduced, it has been found by the writer to give a very sound indication of the relative merits of different machines from the point of view of sparkless running. When the number of turns per spool, lengths of core, widths of slot and tooth and lengths of end connections, etc., are widely varied as between two machines, it is, in fact, impossible by inspection, to estimate their relative inductive voltages unless the data are submitted to definite mathematical calculation. The dimensions of the quantity $\frac{2J\ (L + \Sigma\ M)}{T}$ are those of a voltage, and it is evidently the average rate of change of the self and mutually-induced volts on the supposition of a straight line of current; it is analogous to a reactance voltage, but is preferable thereto as being entirely free from any supposition of a sine wave

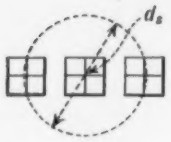


FIG. 31.

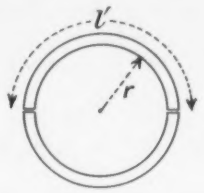


FIG. 32.

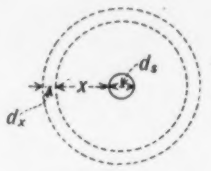


FIG. 33.

of change which is confessedly never met with in the practical dynamo. As a maximum permissible limit for satisfactory running, the writer would give the relation $\frac{2J\ (L + \Sigma\ M)}{T} < 1.75$, while for complete sparklessness with a fixed position of the brushes from zero to full load, $\frac{2J\ (L + \Sigma\ M)}{T} < 1$. Any such statement requires, however, to be checked by a second condition, viz.: that there must not be too great a difference between the densities of the field in which the short-circuited sections find themselves at no load and full load respectively; in other words, there must at full load be either a negative reversing field, or at least a reasonably weak positive field. In short, there must not be too much distortion of the field by the cross ampere-turns of the armature, and the second condition must take the form of a limiting ratio between the ampere-turns required by the air-gap and teeth and the ampere-wires of the armature under a pole. In conjunction, then, with the limiting ratios given above for the inductive voltage, the ampere-turns expended over the double air-gap and teeth should not be less than 1¼ times the ampere-wires under a pole, or 1½ times for a fixed brush position; in fact, as the inductive voltage approaches the lower or higher limit, the ratio may be lowered or must be raised to suit the degree of stringency in the terms of the specification or in the nature of the work.

Data as to Independent Telephonic Growth.

An attempt is being made, as already noted in these pages, by the Queen City Telephone Company, of Cincinnati, to obtain a franchise in that city, and a hearing on the subject was had recently before the council committee on telephones and telegraphs, at which a number of independent telephone leaders appeared and made statements. Mr. James B. Hoge, general manager of the Federal Telephone Company, of Cleveland, said: "In Cleveland, when the independent franchise was granted, the Bell people were operating something like 3,000 telephones, and to-day there are between 20,000 and 25,000 telephones working in Cleveland. In Columbus when the franchise was granted, they had something in the neighborhood of 1,700 telephones. Now that same ratio will hold good in any number of other cities where the independent people have plants in operation, while the Bell Telephone Company from 1878 to 1894 without competition were able to put in use but 243,432 telephones in the whole country. During the next seven years with competition they increased that number to 1,020,647; this from 1895 to 1901, the independents having in operation 1,500,000 in 1901 and in excess of 2,000,000 now."

Mr. Maxime Reber, general manager of the United States Long-Distance Company, of Cleveland, said: "We operate very largely in the State of Ohio. There is hardly an independent telephone exchange in the State of Ohio which has not access to our lines. We have lines that reach up into Michigan, Indiana and connect with the lines of other long-distance companies at those points. We have lines that reach into Pennsylvania and make connections there with Pittsburg; we have lines that reach from the northwestern part of Pennsylvania, there making connections with the companies that are furnishing long-distance service out of Buffalo clear across the State of New York to Albany. While the independent development is of very recent date, and that of the long-distance service has been subsequent to the exchange development, yet to-day there is a very comprehensive system of long-distance lines connecting several independent exchanges in the country from which excellent service is furnished. In our own company we have something over 2,650 miles of pole lines on which are strung about 20,000 miles of wires."

Mr. L. A. Frazee, president of the Home Telephone Company, of Connersville, Ind., said: "I began business in 1895 with 120 subscribers. Prior to that time the Bell company had 52 telephones and they now have 150 subscribers. We have 690 subscribers in Connersville. Wherever a telephone has an influence on trade certain lines of business have almost entirely changed from Cincinnati to Indianapolis. The grocer formerly ordered his goods entirely from Cincinnati; now it is almost entirely from Indianapolis. The hogs and live stock that formerly came to Cincinnati now almost all go to Indianapolis almost wholly on account of the telephone facilities.

"There was a wholesale traveling man in my office telephoning orders. He said he did only 5 per cent. of his business over the Bell, and did not use the Bell at all, only when he could not get the independent. That may seem strange, but the Bell rates are high; it costs to talk to Cincinnati 45 cents for three minutes, and 15 cents additional for every minute over that time; to Indianapolis, 30 cents for five minutes, 6 cents a minute. Now, in addition to that, the wholesale men buy tickets in advance; and Mr. Sherrin, who is president of the New Company, informs me that they give a discount, when they buy $100 worth, of 25 per cent., so that it cuts this down one-fourth, and half of these wholesale men reverse all the messages; my reversed telephone messages are a good part of the business; when the traveling men talk and messages are reversed, it does not cost the traveling man a cent to inquire of his firm in Indianapolis the price of hogs to-day or anything in reference to the market. The message is always reversed."

The following is a selection from the remarks of the Hon. S. P. Sherrin, president of the New Telephone Company, of Indianapolis: "At the beginning of the independent movement, which was in 1895, we had in Indiana all told 6,000 telephones; we had in the city of Indianapolis 1,700 telephones. We now have of independent telephones alone in the whole State of Indiana, 107,000; that is not a guess, gentlemen, it is an actual count; we have 107,000 telephones (independent) in Indiana. In the city of Indianapolis we have 7,725 on our list. The independent busiess was a spontaneous growth. When the Bell patents expired, the people who had been hungry and doing everything they could without telephones for 18 or 19 years, just simply arose in their might and got telephones. We have in the State of Indiana $8,000,000 invested in independent telephones, and of that $8,000,000 there is not 3 per cent. of it outside of the State.

"Now, before the beginning of the independent telephone movement there was in the State of Indiana not a single farmer who had a telephone, not one; now 25,000 are in the houses of farmers. The great benefit to the State of Indiana obtained in the independent development as outlined by Mayor Bookwalter is that these people cannot only reach Indianapolis, but they can be reached. The business of the stock yards has quadrupled since the independent telephone service began at Indianapolis. There is not a man who has a hog to sell in Indiana who has not a telephone. The same thing with the stock of all kinds, and the stock yards people in Indianapolis are in communication with not less than 107,000 telephones. At our office we frequently have a broker send out as many as thirty-five messages at one time. In the morning the stock yards man will call up and say, 'I want Mr. So-and-So at ——' and give the entire list all the way down to thirty-five and goes on about his business. Then our chief operator takes the list and distributes the names to several operators and the man is called, and within an hour he has transacted the business, with men 30, 40, 50 and 75 miles away."

Telephone Transmitters.—I.

BY ARTHUR V. ABBOTT, C. E.

THE magneto telephone is a reversible device and can act either as transmitter or as a receiver; so Prof. Bell's invention solved the problem of the electrical transmission of speech by providing an instrument that could be used interchangeably at each end of the line. In earliest telephone installations only a magneto was provided, which was alternately a transmitter and a receiver, but it needed only a brief experience to demonstrate that while the Bell instrument was so efficient a receiver that the models of to-day show but little change, it was eminently unsatisfactory as a transmitter, for when the magneto telephone is used for transmission it is only possible to converse over very short lines, and even under the most favorable conditions one must so shout as to make the use of the telephone a burden to the speaker, and an annoyance to the listener. But the electrical transmission of speech even in the somewhat uncertain fashion of the earliest instruments, was so stupendous an achievement that every inventor was aroused to an effort to improve, each seeking to use some different electrical principle, either to produce a better instrument or to evade earlier invention.

Every transmitter so far invented operates upon one of the following three principles: *First, electro-magnetic induction; second, electrostatic induction; third, microphonic contact.*

Electro-Magnetic Transmitters.—Naturally first endeavors were efforts at the improvement of the magneto telephone, and it presently appeared under a thousand different guises: Magnets were bent and contorted into numerous curious and grotesque forms, instruments equipped with several diaphragms appeared, and all the possible combinations of the various parts of the receiver were unearthed and tried, until inventors weary of further quest decided that it was necessary to seek in some other direction for an improved transmitter, and the magneto instrument was relegated to the office of the receiver. Nevertheless, for a full survey of the subject, a consideration of the principles of the magneto as a transmitter must not be overlooked, for the operation of that instrument is not quite so simple as at first sight appears, and experts are not unanimous in the explanations offered. Some are disposed to credit the ability to excite electrical waves to a molecular motion of the particles of the iron core under the magnetic changes produced by the movement of the diaphragm. Doubtless this action exists, but it appears insufficient to account for the results produced.

It has been believed that there is some sort of reaction between the spirals composing the field coils—perhaps partly due to an electrostatic action, and partly to an electromagnetic one. But this assumption seems also inadequate. It is certain that the motion of the diaphragm does cause marked changes in the magnetic circuit, which seem to be sufficient to explain upon the basis of electromagnetic induction the operation of the instrument as a transmitter, and on the whole the balance of opinion favors this explanation, though it is probable that all three actions are operative.

If it be true that the ability of the magneto instrument, when acting as a receiver, to initiate sound waves depends upon a varying magnetic field produced by electric currents over the line, the greater the changes in line current the louder the receiver will talk. Hence, the object of the transmitter should be to produce the greatest possible variation in such currents. When the magneto instrument is used as a transmitter, its ability to create pulsations in the line depends upon the amount of motion which its diaphragm can make under the impulse of the sound waves which it receives, and its limitations under such circumstances are very obvious.

When one speaks into any transmitter, only a small percentage of the energy of the sound waves reaches the diaphragm. Owing to rigidity, molecular friction, losses in the magnetic field and the conducting system, the little energy that affects the diaphragm is still further reduced, so that it has been estimated that at the receiving end only two or three-tenths of one per cent. of the energy expended at the transmitting end reappears as sound. Naturally the first attempts at improvement were concentrated upon the diaphragm in an endeavor to obtain a greater excursion; but in this direction the limitations were soon reached, for while it is easy to secure a greater volume of sound, distinctness of articulation is almost at once sacrificed by the confusion which arises from the splitting up of the diaphragm into parts which vibrate independently of each other. So to secure crispness and distinctness the diaphragm must be thin, and vibrate through a small space, considerations which obviously preclude a magneto instrument from developing powerful impulses in the line.

Electrostatic Transmitters.—One of the earliest attempts to improve the transmitter was an effort to utilize electrostatic induction instead of electromagnetic. A telephone operating upon this principle was brought out by Mr. Edison in 1877. Fig. 1 shows the general method adopted. In the model, *A*, a resonant chamber, *V*, having a mouthpiece, was provided around the circumference of which a number of plates, *P*, were placed, which were connected through a battery to the line. Just inside of this row of plates a second set was placed, which were free to vibrate under the sound waves. As the plates moved to and fro they increased and diminished the space intervening and thus varied electrostatic capacity. A more practical model is shown at *B*, in which there are a number of metal plates free to move, separated by insulating material. One set of plates is connected to one side of the line and the other set to the other side. Speaking against the front plate of the system sets up a vibratory motion between all the plates, thus varying electrostatic capacity. Instruments of this kind are found to give exceedingly excellent articulation, and will act both as transmitter and receiver; but like the magneto instrument, they are very deficient in power and can only be used on the shortest lines and under the most favorable circumstances.

Microphonic Contact Transmitters.—The next step was to provide some exterior source of electricity which should be entirely inde-

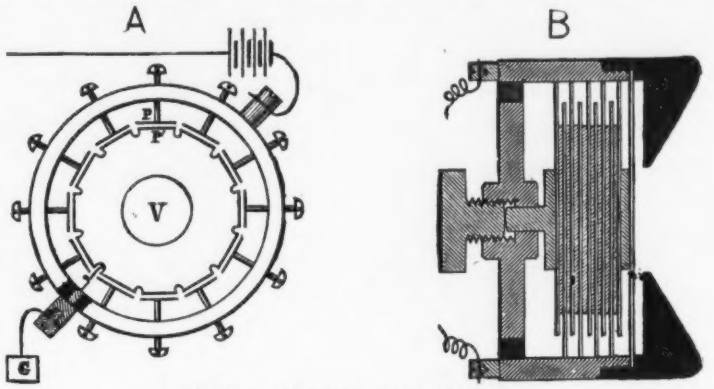


FIG. I.—CONDENSER TRANSMITTER.

pendent of the motion of the diaphragm, capable of delivering to the line any desired volume of current, and then to arrange the vibrating system to be merely a regulator, or valve to control the amount of current, so that it shall be proportional to the acoustic waves. A somewhat similar example is that of a gun. The energy that propels the ball resides in the charge of explosive, and a very feeble pressure upon a properly-arranged trigger is sufficient to release an enormous amount of energy. It was hoped that by providing a battery to supply the electrical energy, a vibrating mechanism could be invented that should control this current in accordance with the sound waves. In other words, the transmitter ought to be a valve operated by the sound impulses which should allow more or less current to flow. In a rough way an ordinary Morse key operates upon this plan, for under the touch of the fingers it injects into the line squirts of electricity from the battery, whose relative duration and frequency form the telegraphic alphabet.

It was upon this plan that the old Reis telephone was built, which consisted of a battery and a diaphragm that carried a platinum contact which opened and closed the circuit with every sound wave, but for the successful transmission of speech something infinitely finer and more delicate was necessary. In the Reis telephone the surface of the bearings were made of polished platinum and all possible pains taken to obviate the resistance, which even at that time was well known to exist in a circuit containing an imperfect contact. Therefore, when the contact pieces touched each other there was essentially no resistance in the circuit, save that of the metallic conductors, and if the contact pieces were separated by ever so small an amount the resistance of the circuit was almost infinite. It was a dead open-and-shut affair, with no possibility of any intermediate condition that could render the gradations necessary to articulate speech, so this apparatus was only a slightly refined reproduction of the Morse key, capable of sending little else than dots and dashes.

For several years prior to the appearance of the Bell telephone it had been known that an imperfect contact introduced great resistance into an electrical circuit, and that this resistance would vary widely with the pressure applied to the surfaces. But all inventors had ignored the possibility of utilizing this fact in the construction of an electro-acoustic valve that would produce a more powerful transmitter. In 1877 Mr. Edison produced a transmitter whose operation he explained upon the theory of varying pressure applied to a bit of carbon. This transmitter is shown in Fig. 2. *A B* is the diaphragm against which the sound waves impinge, in

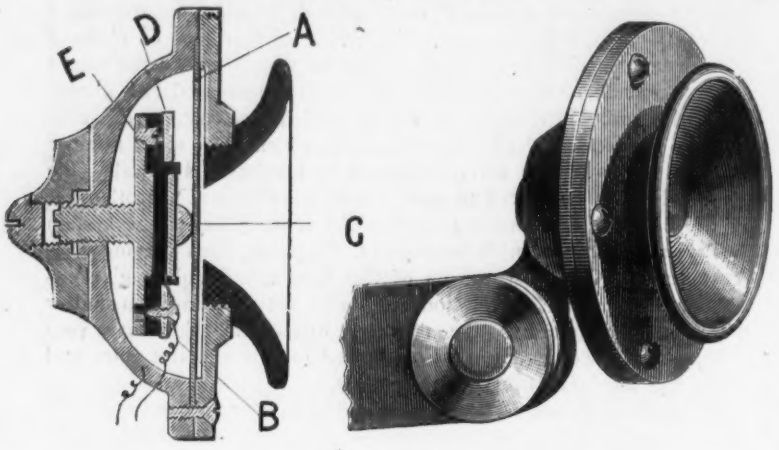


FIG. 2.—EDISON CARBON TRANSMITTER.

the center of which is a button, *C*, which presses against an electrode, *D*, which is in contact with a thin circular cake, *E*, made of compressed lampblack. This rests against a metal button that forms the other electrode. Over transmitters utilizing either electromagnetic or electrostatic induction this instrument was a vast improvement, and it probably operated on the principles now included in all carbon transmitters.

Mr. Edison is reported as explaining the operation of this transmitter by assuming that the specific resistance of the carbon button varied very greatly under pressure, and that the slight changes in pressure, due to the motion of the diaphragm, were sufficient to account for the improvement in the volume of transmission. Experiments have since shown that with any pressure up to the actual crushing point of carbon there is too little change in its resistance to make this theory a satisfactory one. About the same time, Mr. Berliner, while practising with the Morse key, discovered that the resistance of an imperfect contact could be greatly varied by a slight change in the pressure applied thereto, and, on April 4, 1877, filed a caveat in the American Patent Office covering this principle. About a year subsequently Prof. Hughes published a description of an instrument which he termed the microphone, on account of its apparent ability to greatly increase the loudness of faint sound.

There seems little reason to doubt at all that both Berliner and Edison were the earliest *constructors* of microphonic transmitters; but, either owing to the reticence imposed by patent law, or by a failure to fully comprehend the extent of the discoveries embraced in their models, these inventors failed to describe their inventions in so clear a manner as to reserve to themselves the full credit thereof. Prof. Hughes sought no patents and certainly was the first one to fully and clearly *describe* the action of the microphonic contact.

A microphone built upon the Hughes plan is illustrated in Fig. 3, from which it is seen that the foundation of the instrument consists of a box which acts as a resonant chamber. In the illustration a cigar box is used to show how easily such an instrument can be made. Upon the box a small piece of carbon is placed upon which a lead pencil or any piece of carbon rod stands, the upper portion of which leans lightly against another carbon block. A dry cell and a receiver are placed in circuit with the carbon pencil; if, under these circumstances a faint sound wave impinges upon the box, the receiver will emit a greatly intensified reproduction, and by adjusting the carbon rod so that a very poor contact is made with the carbon blocks, the instrument can be made almost incredibly sensitive. The ticking of a watch placed upon the sound board reappears as the roar of a boiler shop. The footsteps of a fly become the tramp of an army, and if carefully adjusted the microphone talks astonishingly as compared with the transmitters of twenty-five years ago.

In describing the operation of the microphone, Prof. Hughes recognized that an imperfect contact, which had so long been the *bête noir* of the electrician was responsible. He assumed that in the case of an imperfect contact a great resistance was introduced into the circuit, but that a very slight change in pressure was able to vastly change such resistance, with a corresponding increase or decrease in the current. For telephonic purposes the very thing which electricians had striven to avoid was the one solution of the problem. Prof. Hughes showed that the material of which the microphone was constructed mattered little, and that almost any substance would be operative provided the contact between its surfaces was poor. As shown in Fig. 4, it is feasible to construct an excellent microphone out of three screws, one of which is laid across the other two, and it matters little whether they are iron or brass, only the older, dirtier and more rusty, the better. The operation of the microphone is explained as follows: Under normal conditions the carbon rod stands loosely upon the lower block, and leans very lightly against the upper one. There are, therefore, two places of contact between which the pressure is exceedingly small. Consequently, the resistance of the circuit at these points is large and but little current will pass. Suppose a sound wave impinges upon the apparatus, throwing all of its parts into vibration. Owing to inertia, the carbon rod and the blocks do not move mathematically together. Consequently, the pressure between the contact surface varies with every sonorous intonation, increasing and decreasing as the wave ebbs and flows and exactly in proportion thereto. Now, while the actual change in pressure between the surfaces is exceedingly small, even when measured in a fraction of a grain; yet the fact remains that an almost inconceivably minute change in pressure can produce a relatively very great change in the electrical resistance of a bad contact. Therefore, a small sound wave may produce a great variation in the current traversing the receiver, and so excite in its diaphragm vibrations of great amplitude, with a production of correspondingly loud sounds. The microphone does *not magnify* sound in the same sense in which the microscope enlarges the object at which one gazes, for the receiver only repeats the *energy changes* in the current in the circuit, and these energy changes may, or may not, faithfully repeat the sound waves that originated them. The fact that under the very best conditions speech reproduction is markedly imperfect is conclusive evidence that microphonic reproduction is by no means infallible. While it is certain that the success attending the employment of the microphone as a speech transmitter is due to the changes in contact resistance, we are quite in the dark as to how a slight change in pressure is able to effect such a marked

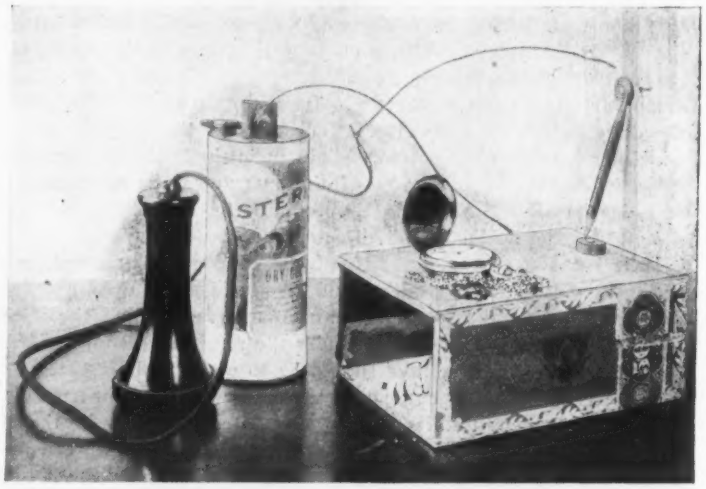


FIG. 3.—ILLUSTRATION OF HUGHES MICROPHONE.

change in resistance. There are four theories, none of which is entirely satisfactory, and it is probable that all play a part.

First, there is the theory originally advanced by Mr. Edison that a change in pressure effects an actual change in the specific resistance of the material employed. This theory has probably the least support.

Second, it is believed that upon the surface of bodies resembling carbon, air and other gases exist in a peculiar state of condensation about which very little is known, and that very slight variations in pressure affect both the thickness and the state of condensation of the gas envelope that encloses every particle. It is supposed that this variation may be sufficient to account for the changes in re-

sistance. Mr. Berliner has recently advocated this explanation.*

Third, according to the atomic theory, it is supposed that even in the densest solid the ultimate molecules are not in contact, but are separated by spaces which, in proportion to molecular sizes, are very great, and that the cohesive attraction to which the strength of all bodies is attributed is not due to actual contact between the particles, but merely to the fact that many of them have come within each other's sphere of attraction. In the case of a bad contact it is imagined that only a few molecules of one body are close enough to those of the other to be within this sphere. So it is quite conceivable that a very slight increase in pressure might result in squeezing an enormously greater number of molecules within each other's

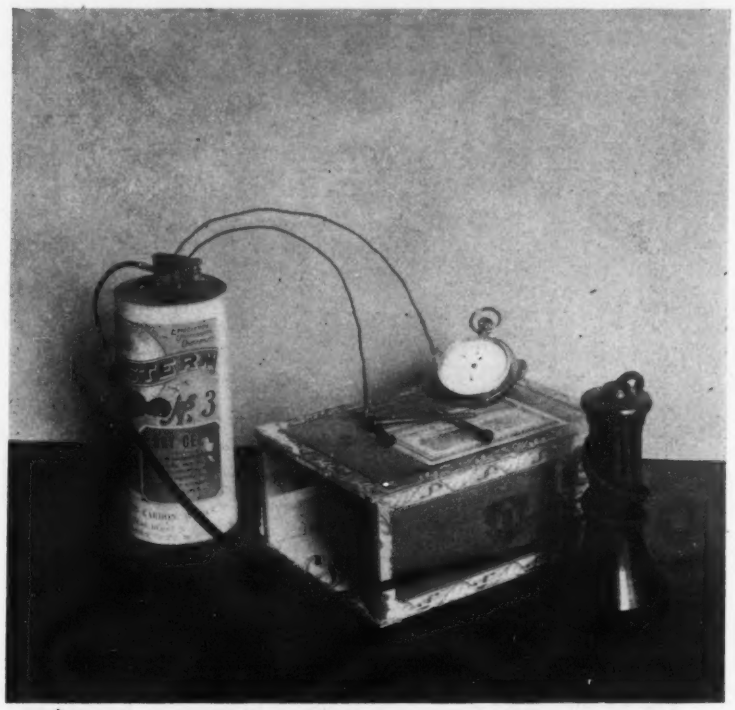


FIG. 4.—ANOTHER FORM OF HUGHES MICROPHONE.

orbit. On the whole, this theory seems to be the most probable, and has the greatest number of adherents.

Fourth, it is imagined that between the carbon particles slight arcs may form, and that as the resistance of carbon varies very rapidly with changes in its temperature a slight current may warm the carbon sufficiently to lower its resistance markedly. This would cause a still greater current to flow, with further heating, so that the carbon would react upon itself and continually allow more and more current to pass. That arcs do form in carbon transmitters, experience amply proves, but as soon as they occur the quality of transmission almost immediately changes and the listener is at once made aware that something unusual is happening. Usually the character of transmission is unfavorably affected, so that this explanation seems inadequate.

Whether any or none of these hypotheses shall prove to be the true explanation of microphonic contact, the future only can decide, but whatever that verdict shall be, it is certain that to-day every successful commercial transmitter is a microphone in some form or other, and so a study of commercial instruments leads to a classification according to the way in which microphonic contacts are employed.

1st. The single-contact transmitter.
2nd. The series-contact transmitter.
3rd. Multiple-contact transmitter.
4th. Multiple-series transmitter, or granular instruments.

Steam Turbines for Warships.

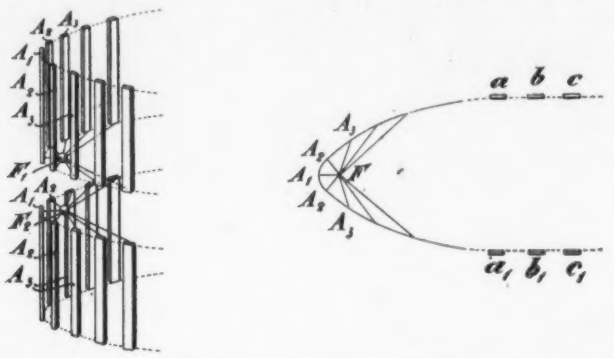
According to a Washington dispatch a board of naval officers has submitted a report to the Navy Department strongly asserting that steam turbine engines are adapted for naval purposes. It is thought that the Navy Department will endeavor to secure an appropriation to test steam turbines in some torpedo boats. The English navy is now equipping some of its ships with turbines.

* See *American Electrician*, March 7, 1897.

Directing Waves in Wireless Telegraphy.

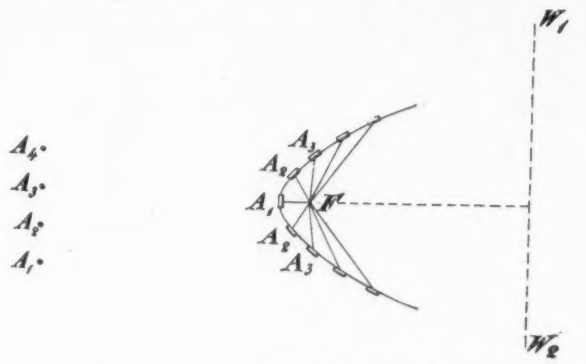
An interesting patent has just been issued in this country to Mr. F. Braun, of Strassburg, Germany, on means for directing waves for use in wireless telegraphy. The application was filed in this country on February 19, 1902. The invention relates to reflectors and consists chiefly of a metallic grating of parabolic form.

Fig. 1 is a diagrammatic view illustrating the theoretical physical principle. Fig. 2 is a section of the new reflector. Fig. 3 is a perspective view, while Fig. 4 represents an improvement or modification of the reflector by means of deflectors. It is well known in optics that series of luminous lines located in one plane and parallel to each other at equal distances apart and having the same phase and amplitude of oscillation will produce what is called in optical science a "wave front," which is a plane. These lines are indicated in Fig. 1 by points A^1 A^2 A^3 A^4, which represent sections of the



FIGS. 1 AND 2.—DIAGRAM ILLUSTRATING PRINCIPLE OF REFLECTION.

luminous lines making up the wave front normal to the plane of the drawings. The same effect can also be obtained by the arrangement of a parabolic mirror. If, for instance, in Fig. 2 F is the luminous point and A^3 A^2 A^1 A^2 A^3 are parts of a parabolical mirror of cylindrical shape, W^1 W^2 will indicate the wave front which is a plane. This method may be employed for wireless telegraphy in the following manner: A series of parallel rods, A^3 A^2 A^1 A^2 A^3, are arranged at equal distances from each other, so as to produce a cylindrical parabolical mirror in the form of a grating. Each rod is connected by a straight wire to a small ball, F, set in the focus line of the mirror. As shown in Fig. 3, two sets of rods are provided for, and between the two balls, F F', set in the focus line a spark is generated from time to time by a Ruhmkorff apparatus or an electrical static machine. This is not shown here, however. Now it will be evident that as all rods are excited from the same center and as the phase difference of the oscillations of the single rods is determined by the length of the corresponding wires the set of rods act in such manner as to generate a wave front which must be in a plane. The wave motion, therefore, will be essentially rectilineal.



FIGS. 3 AND 4.—DIAGRAM OF REFLECTOR.

It is obvious that by these means the greatest amount of the radiating energy will be guided in one direction. The phenomenon is physically analogous to the ordinary parabolic mirror and to Hertz's mirror for electric waves. Its peculiarity, however, is that every rod fulfils its own oscillation, provided it is tuned by ordinary means, as capacity and self-induction, to the same periodicity.

The advantage of the new system over the ordinary metallic continuous parabolic mirror is that much more energy is set in action, as the energy depends on the capacity of the single rods, which may be increased by increasing the capacity of the rods and adding,

for instance, condensers to the same. A further advantage may be secured by suitable additional rods, *a b c*, Fig. 4, or similar bodies—as, for instance, human bodies. These bodies act to prevent lateral deflection.

Recent Developments in Multiplex Telephony.

An invention of considerable interest to all engaged in telephony is that recently announced by the issuance of a patent to Mr. Willard M. Miner covering the art of practical multiplex telephony. Mr. Miner's invention appears to be a wide departure from generally recognized standard practice, although based on well-known laws of physics. The study of acoustics reveals a situation having unusual bearing on the art of transmitting several conversations over one circuit at one time. Mr. Miner was associated with the late Lieut. F. Jarvis Patten, who it will be remembered invented a system of multiplex telegraphy and did important work on alternating-current apparatus. Mr. Miner has also been a student of telephonic matters generally for a period of over 20 years and has thus had more than a passing interest in acoustics as applied to music. Several years ago he and others acquired the patents and apparatus of Lieut. Patten used in the development of his multiplex telegraph system and undertook to apply such apparatus to the development of multiplex telephony, but it was found after exhaustive experiments that the Patten telegraph apparatus was commercially inoperative telephonically.

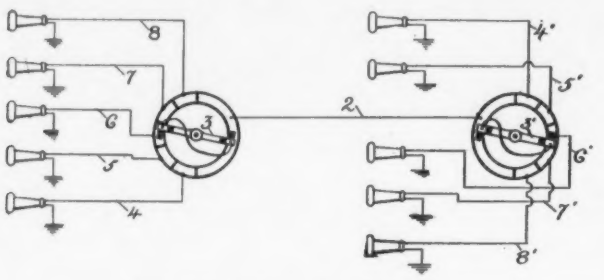


FIG. I.—MULTIPLEX TELEPHONY.

It was at this point that Mr. Miner began the application of his studies in acoustics to the transmission of speech in multiple, finding that there was a wide difference between interruptions of the circuit and closing the circuit at frequent intervals. For instance, it was found that 100 interruptions per second would not affect the transmission of speech, and on this theory other investigators have been working for some time. But when the number of closures or contacts is considered, on which multiple telephony is based, an entirely different field is opened up. With 100 interruptions speech is possible. With 100 contacts or closures per second, speech may be possible, but certainly it is not commercial. In multiplex telephony the basic principle is that of successively closing the circuit of the different branches or multiples of the line, it being necessary that all other branches should be disconnected except the one actually

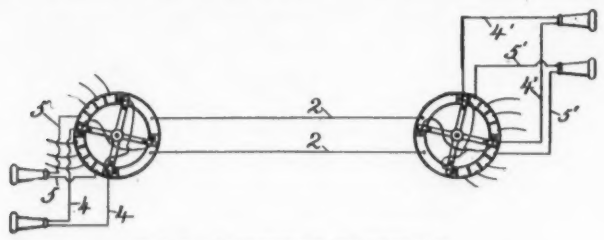


FIG. 2.—MULTIPLEX TELEPHONY.

engaged; and Mr. Miner came to the conclusion that in order to secure commercial multiple telephony it would be necessary to have contacts or closures to correspond as near as possible with the frequency of the vibration of the human voice in singing or speaking. In other words, the principle of the invention is to have a contact or closure provided for each and all of the vibrations of the human voice in spoken words and all musical tones.

By means of the Patten-Miner system of multiplex telegraphy Mr. Miner secures synchronism, the fundamental feature of all multiple telegraph or telephone systems. His recent invention is the outgrowth of the above system and by associating these two important inventions together, a complete multiplex telephone and telegraph system is secured.

It will be understood, then, that the apparatus devised by Mr. Miner, while in its general form the same as that heretofore used for multiplex telegraphy—or telephony for that matter—such apparatus is run at a much greater speed so as to bring the frequency of the closures of connection upon the several branches or subcircuits up to a rate approximating in greater or less degree the rate of the vibrations of the overtones characterizing speech. A rate of closure of 1,000 or 2,000 per second will not answer the purpose, but as the rate increases and passes beyond 3,000, improved results become apparent, and are markedly better when a rate of 3,500 or 3,600 per second is reached; the best results being obtained with a rate of about 4,300 per second.

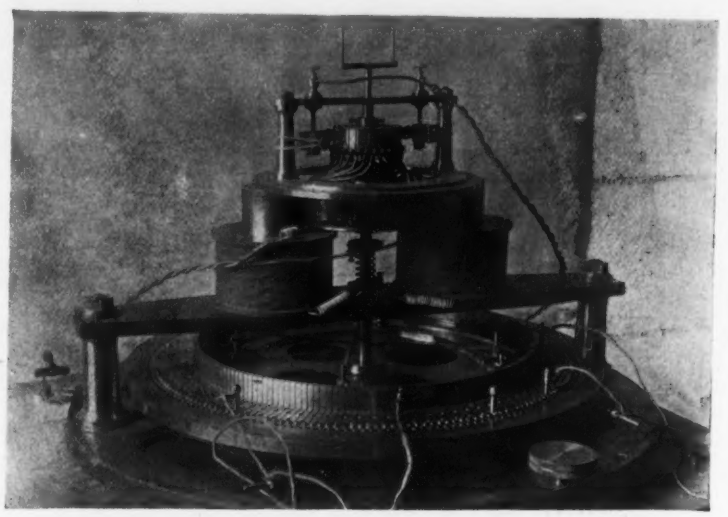


FIG. 3.—PATTEN DISTRIBUTER.

The accompanying cuts, Figs. 1 and 2, illustrate in diagrammatic fashion a pair of rotating circuit closers or distributers in a typical form sometimes employed for multiplex transmission over a single line circuit. The rotary arms at opposite ends of the line 2 are marked 3, 3′, respectively. They are kept in synchronism by any means known in the art, and each is shown as rotating over five contacts, to which are connected respectively the five-branch or subcircuits, 4, 4′, 5, 5′, 6, 6′, 7, 7′, 8, 8′; the correspondingly numbered branches include the telephonic apparatus or sets of apparatus that are used in conjunction for conversation. The circuit shown is a ground circuit, but, as will be obvious, the apparatus might be organized in the well-known manner as is shown in Fig. 2, to provide a metallic circuit for each telephonic transmission.

Fig. 3 shows one of the original Patten "mills" or distributers.

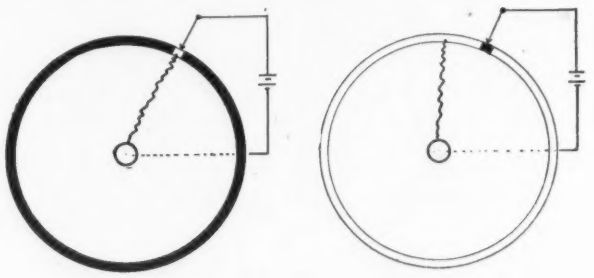


FIG. 4.—MULTIPLEX TELEPHONY.

Mr. Miner had this machine with him in the West in 1891 when making telegraphic tests between Chicago and Minneapolis. It and another like it have also been used by Mr. Miner in his multiplex telephone experiments in New York City. Fig. 4 shows the difference between 100 contacts or closures per second on an electric circuit and 100 interruptions per second. If the two wheels shown are revolving at a speed of 100 revolutions per second, one will give 100 contacts per second, while the other will show 100 interruptions per second, with a decided difference, it is said, between the two sets of phenomena and the consequent result.

Single-Phase Motors for Traction.

In the preceding issue appeared an abstract of the first portion of a paper on single-phase motors for traction, read by Dr. Giorgi Finzi at the annual meeting of the Italian Association of Electrical Engineers, held at Naples October 11. Below is given an abstract of the concluding portion of the paper, in which the Finzi single-phase railway system is described in detail:

Tests of the Finzi single-phase traction motor showed that for a given torque the current is slightly higher with a higher voltage, and this is more pronounced when the torque is greatest. The characteristic thus shows a number of slightly divergent torque-current curves. Curves of efficiency and power factor at various voltages in function of the speed were laid down. In the efficiency curves the higher branch corresponds to lower speeds when the voltage is lower, so that even though the efficiencies be not particularly high, the motor always works under favorable conditions, its speed being generally lower when the voltage is kept lower. The power factor is shown to be high when the speed is above the lowest figures.

This motor was geared to one of the ordinary cars used by the Edison Company, of Milan, for city service, replacing the direct-current equipment consisting of a motor (0.7 ton), a controller (0.072 ton), and the rheostats (0.08 ton). The weight of the fully-equipped car was 6.7 tons and of the stripped car, 5.85 tons. The single-phase motor installed weighed 0.8 ton and the controlling transformer 0.5 ton, making a total of 7.15 tons. To save time a standard 40-kw transformer was used for controlling, though one of 14 kw, weighing 0.25 ton, is sufficient, giving a total weight of 6.85 tons for the fully-equipped car.

The circuits on the car are shown in Fig. 1. The line from the trolley has a switch, *I*, on one platform, then passes to the other platform, where the controller is placed, then through an ammeter, A_1, a fuse, *v*, another switch, and then to an auto-transformer, and finally to earth. One brush of the motor, *R*, is earthed and the other brush goes to the field, *E*, thence to the handle of a controller, *T*, which takes current from different points of the transformer winding. These points are five in number, corresponding to 80, 100, 120, 140 volts, with a 500-volt supply. On the trial the passing of the five points was made with absolutely non-sparking. It will be seen that the five points are running points; for stopping, either of the two switches is opened; of course, the controller, as designed for practice, has a dead section for stopping. Through a switch, *C*, the fields are reversed to run in the opposite direction. An ammeter, *A*, showed the current in the motor, and a voltmeter, *V*, the voltage. All testing instruments in the car were of the hot-wire pattern. A special circuit from trolley to earth carried the incandescent lamps, *L*, of the car.

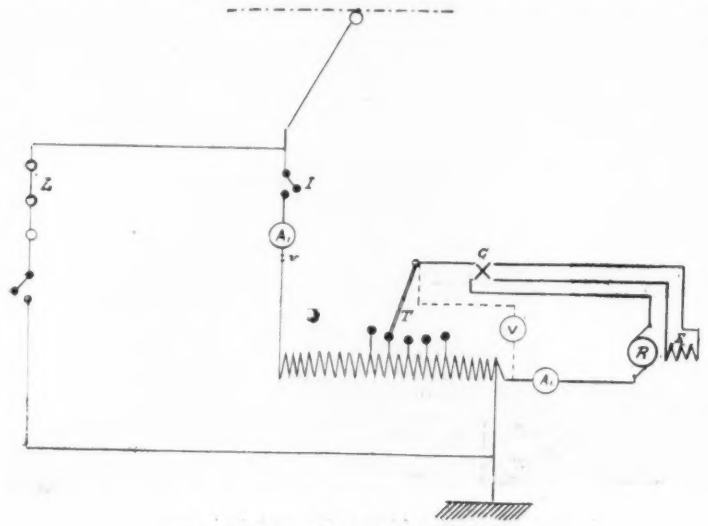


FIG. 1.—DIAGRAM OF CAR CIRCUITS.

The usual way of gearing the motor was adopted, a standard pinion (14 teeth), geared to a 67-teeth wheel (4.78 ratio). The diameter of the car wheels was 77 cm. A Kapp accelerimeter was fixed on the car, while for measuring the speed several methods were used, the final and most exact one being to get it indirectly from current and voltage through the test curves of the motor itself.

The generating station is near the laboratory in the Edison Company's works at Porta Volta, and contains a 60-hp, 3,600-volt, three-phase induction motor belted to an old eight-pole alternator with rotating armature, that gave a frequency of 18 at 270 r.p.m. The exciter was an old type Edison dynamo with a slender upright field.

The voltage of the alternator was raised from 90 volts to about 550 by an auto-transformer. The instruments were a hot-wire ammeter, a Thomson integrating wattmeter, and a Siemens wattmeter, which was replaced after some nights by one of the excellent Olivetti recording wattmeters specially arranged for the experiments. Another voltmeter showed the line voltage, which varied from 575 volts on open circuit to about 520 volts when the car was running.

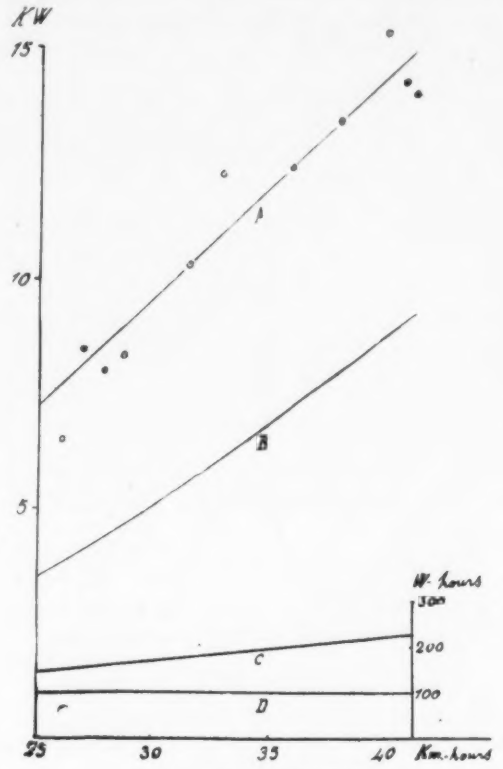


FIG. 2.—ENERGY CURVES.

The greatest number of runs was made during the night on the municipal line connecting the Monumental Cemetery with the new Musocco Cemetery. When the ordinary traffic was stopped the Musocco and the Cagnola sections were disconnected from the continuous-current system and the alternate current was fed in. The track had Vignoles rails for its whole length—about 5 km.—with a considerable number of switches and several curves of small radius. A crossing over a railroad railway has a grade averaging 25 per cent. for 225 metres on each side, and the whole line has an average grade of 2 per cent. from Musocco to the Monumental Cemetery.

The test runs began on June 29, 1903, and continued for ten nights. The last two nights' runs were made through the city of Milan, over the tramcar lines (Phœnix rails) with a trailer, through Bramante-Principe, Umberto Vincenzo, Monti-Monforte, and nearly the whole of the outer circle. The total mileage of the car was about 200 km. Not the slightest difficulty was experienced with the electric equipment, and it is remarkable that even the grade and curve at the Central Railway station were passed over, though not very easily, by the car with full load and one trailer, though, owing to the drop of voltage of the generator, the motor received only 95 volts instead of 160 volts.

The very first tests showed very smooth speeding up, and there was the same absence from sparking as in the laboratory tests. The satisfactory commutation was chiefly apparent in starting, when the motor in every way behaved better than the corresponding continuous-current traction motor. Some little sparking occurs from time to time, when the full voltage is fed, but not more than is usually observed in a good standard traction motor. The infrequent sparks did not show the color or the light of an arc, resembling rather carbon particles torn away from the brushes. As a matter of fact, the 200-km. run left the commutator perfectly clean and smooth, with the same appearance as it showed at start, and the brushes showed no measurable wear.

The car was lighted with the same lamps that were on the ordinary 500-volt circuit—six incandescent lamps in series. The slightly

higher alternating voltage made them burn more brightly than usual; the fluctuations of the pressure were not very noticeable, and would disappear altogether by the use of standard lamps of 50 volts or less, instead of 100-volt lamps.

The object of the tests was, on one hand, to determine the general working of the motor with respect to its specific qualities for traction use, and on the other to measure how much power the runs and the startings absorb, in comparison with standard continuous-current equipments.

With these objects the runs were of two different classes. During one simultaneous reading of the instruments were taken, together with diagrams from the Olivetti wattmeter, which gave the power necessary to keep up the various speeds when once attained. These

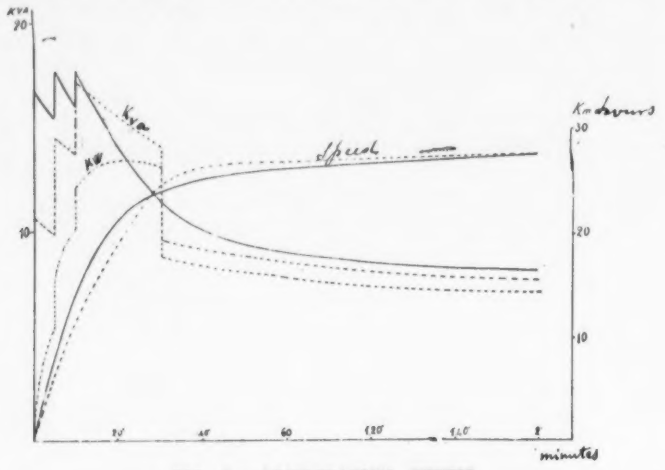


FIG. 3.—ACCELERATION CURVES.

runs had very few startings—in fact, only those that were necessary. On other runs frequent stops were made and thus an exact knowledge obtained of the starting data. The readings from the integrating wattmeter at the end of the runs showed the difference due to a given number of startings in comparison with the energy absorbed by a run without startings. The same course was carefully followed with another car equipped with a four-turn standard General Electric 52 motor.

The results are not of a very high degree of accuracy; in fact, no traction experiments can be entirely accurate owing to the difficulty of getting exact simultaneous readings, and to the complex elements of the experiment. The experiments are, however, trustworthy so far as they go, and show satisfactory concordance with results arrived at by other methods.

In Fig. 2 the line, *A*, shows the power at the generating station that is necessary for a 10-ton, single-phase car, on a level straight track, at speeds between 25 and 40 km. per hour. This curve is averaged from all the experiments, and is the collective result of the Siemens wattmeter readings at measured speeds, and of the Olivetti diagrams. The experimental points are rather dispersed, but not more than was anticipated from having a track with many grades and with few short, straight sections on which a constant speed could only be kept up a short time. The *B* line shows the power given by the motor, and is obtained from *A*, taking account of the line loss, the transformer loss and the efficiency of the motor (given the voltage and the speed).

The line, *C*, gives the energy in watt-hours per 10-ton car-km. from the motor; line *D* gives the energy dissipated per car-km. in mechanical friction—that is, after subtracting the air resistance. This last was computed considering the shape of the car and taking advantage of the coefficients found in the latest experiments (Finzi and Soldati on air resistance). Thus, mechanical friction absorbs 10 watt-hours per ton-km., of which about 0.5 is gear friction. This leads to a traction coefficient of 3.48 kg. per ton, a very normal figure for a level straight track and for Vignoles rails.

The paper contains a comparison between single-phase and direct-current motor acceleration based on the composite results from various experiments, made some in one, some in the opposite direction, to eliminate the influence of the average 2 per cent. grade.

On a city tramway system a maximum speed of 22 km. per hour is necessary between successive stops to get an average speed of 17 km. per hour, and the comparison is made on this basis, with almost the same acceleration for the two test cars. A speed of 22 km. per hour on an average acceleration of 0.25 meter per second is found for the single-phase motor, and 0.28 for the General Electric 52. Even after starting a lower absorbed power is found for the single-phase (though its efficiency be a trifle lower) on account of the resistances the General Electric 52 still has in series with it. When the power curves are integrated for each motor to a 22-km. speed, for the single-phase, 9.4 watt-hours per ton are found, and for the General Electric 52, 12.35 watt-hours per ton. If the integration is referred to a 23.5-km. speed, which both motors attain in the same time, but in a slightly greater distance with the General Electric 52, the figures become, for the single-phase, 10.6 watt-hours per ton, and for the General Electric 52, 14.85 watt-hours per ton. If these figures are modified to correspond to the 22-km. speed, they become, for the single-phase, 9.35 watt-hours per ton, and for the General Electric 52, 13.1 watt-hours per ton. The theoretical amount of energy required for starting to the 22-km. speed would be 6.6 watt-hours per ton.

The following data, from those experiments, correspond to an average speed about the same, but with different accelerations:

Distances.	Weight, tons.	Average speed.	Maximum speed.	No. of starts per km.	Watt-hours per ton—km.		Watt-hours per start per ton.	
23.6	7.78	21	25	1.02	43.1	11		11.6
10	9.05	20	22	0.33	33.2			
10	9.45	23.5	25	0.26	32.6			
20	8.21	17	21	1.35	37.2	10		
10	7.78	17.4	22	2.03	43.2			

The acceleration was computed by taking into account the slowing-downs and assuming three slowing-downs to one stopping. The last figures have no great value *per se,* because a small error in measuring the maximum speed between two stops is enough to vary the results appreciably; however, they coincide well enough with the figures as obtained from test curves, if the line and transformer losses are taken into account.

The watt-hours per ton for starting with continuous current (12.2 to 13 to a 22-km. speed) are much lower than M. Blondel accepts from the examination of various tests. M. Blondel assumes the empirical formula, $V^2/30$, which would give in the present case 16 watt-hours. But even the figure used shows a 25 per cent. economy in favor of the single-phase system, which means much when it is considered that the power absorptions for starting on a city thoroughfare are 50 per cent., and sometimes as much as 65 per cent., of the whole consumption of current.

The wattmeter diagrams taken at the generating station showed,

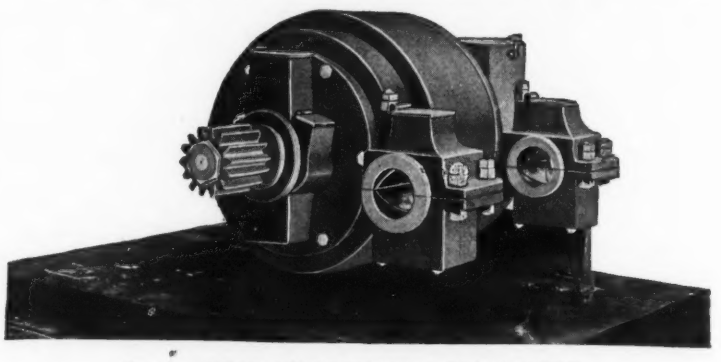


FIG. 4.—FINZI SINGLE-PHASE RAILWAY MOTOR.

for the single-phase system (9.45 tons), 4,250 watt-hours, or 45 per ton-km.; and for the direct-current system (9.65 tons), 6,750 watt-hours, or 70 per ton-km. The difference is due, partly to the fact that, in order to remain within the speed limits established (and which correspond to those of a city traffic) the direct-current motor had almost always to work with resistances in series. But even this shows the advantage presented in similar conditions by the monophase motor, which allows very wide range of velocities without lowering the efficiency at normal speed.

As to the power factor, it varies between rather wide limits, according to speed and voltage. The characteristic curves of the motor give the standard startings an average power factor of 0.7. On the other hand, if wattmeter diagrams are compared with the

instantaneous current and voltage figures at the station during the run, the aggregate average power factor (for line, transformer, motor) is 0.8, varying between limits of 0.6 and 0.95.

Recent Electrochemical Developments.

REDUCTION OF METALS AND ALLOYS.

It has been frequently found by experimenters that when an oxide of a metal whose temperatures of reduction and volatilization are nearly the same, is mixed with sufficient carbon to combine with the oxygen, is heated to the temperature of reduction, the main resulting product is not the metal which is wanted, but a carbide. The reason is thought to be that the metal becomes volatile as soon as it is formed and combines with free carbon present in the mixture. In a patent granted to Mr. F. J. Tone, engineer of the Carborundum Company, of Niagara Falls, these disadvantages are overcome by maintaining proper conditions of temperature, proper distribution of heat, and proper arrangements of the charge.

The method may be described by its application to the production of silicon for a mixture of silica and carbon. The constituents are finally subdivided and thoroughly mixed and the design of the furnace is such that the discharge of heat is over a wide zone (as opposed to localized heat) so that the progress of the reaction is relatively slow and the best conditions are maintained for agglomerating the particles. The most even temperature possible is maintained throughout the zone of reaction, to prevent the silicon from being volatilized as soon as formed, and the charge is so arranged in the furnace as to allow globules of reduced silicon to drop by gravity out of the zone of reaction to a lower portion of the furnace.

It is evident that for these purposes an arc furnace would be unsuitable. Mr. Tone, therefore, employs a resistance furnace, a vertical section of which is shown in Fig. 1. The heating resistance in the center of the furnace is made up of carbon blocks piled together with intervening spaces. The charge is fed into the furnace

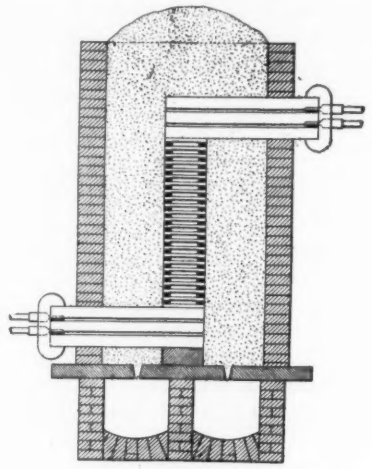


FIG. 1.—VERTICAL SECTION OF TONE FURNACE.

at the top and as the silicon is reduced it sinks down into the cooler portion of the furnace and finally into the receptacles at the bottom, where it solidifies as a metallic block.

INTERRUPTER.

A patent granted on November 24 to Mr. T. A. Houghton, of Rochester, N. Y., refers to an improvement of the Wehnelt type of interrupter for the purpose of allowing adjustment within wide limits. The cathode is made in form of a worm through which a continuous stream of cold water is run in order to keep the temperature down to the proper point. The anodes are made adjustable in order to be able to vary the area of exposed surface. The anode remains stationary (except during any adjustment), while the interruption is caused in part by the movement of an insulating member which shields the anode from the electrolyte. A plurality of anodes is used in order to increase the range of frequency of interruptions.

BATTERY INVENTION.

A patent granted to Mr. J. Bijur, of New York City, refers to a form of Plante plate which is claimed to be cheap and to have all the advantages of the more expensive forms. No other metal is used than lead or lead and antimony, anything else, for example, tin-lead solder, being objectionable. Each plate contains several panels, a magnified view of a part of a panel being given in Fig. 2. It will be seen that the finished plate consists essentially of a great many lead strips, *s*. The plate is made by arranging as many groups of strips, *s*, as may be desired, with or without short bars, *b*, of lead of the same length as the strips at intervals in the groups. The

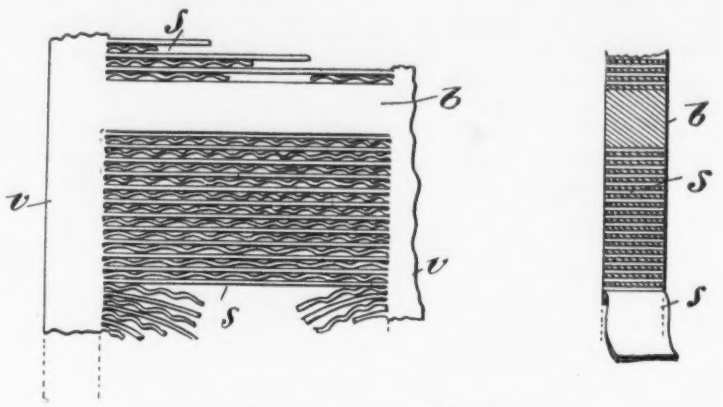


FIG. 2.—BIJUR STORAGE BATTERY PLATE.

groups are arranged in a mould and heated nearly to the melting temperature of lead. Then melted lead superheated considerably above the melting point, preferably at about red-heat, is deposited in the intervals to form the ribs, *v*, the essential point of the process being that the melted lead is hot enough to fuse the ends of the strips.

A patent granted to Mr. F. W. Buehne, of Freiburg, Germany, refers to an accumulator plate which consists of a felted mass of cut filaments of metal, compressed along lines ranged to form a support, and an open grid for supporting the active mass. The felted mass is made from fibres obtained by a process formerly patented by the inventor.

A patent granted to Mr. W. Heym, of Berlin, Germany, relates to a pocket battery made up of two holders of celluloid containing the active mass and metallic lead strips. These holders have a contraction near the top. In the manufacture of the cell oxides of lead are used as active mass. The space between the two celluloid holders is filled with an electrolyte for charging the cell. After the cell has been charged, the formative electrolyte is removed and replaced by a gelatine electrolyte. The cell is sealed above the contraction. It is not intended to recharge such a battery after it has once been discharged.

A patent granted to Mr. P. Kennedy, of New York City, refers to mechanical details of a flexible conductor for connecting the positive terminal of one cell with the negative terminal of another cell in a battery.

A patent granted to Mr. W. L. Winters, of Chicago, refers to the structural arrangement of various cells in a battery by means of which the different cells can be connected together in a desirable way with but little trouble.

Jernegan in Manila.

The Rev. Prescott F. Jernegan, who achieved considerable notoriety in this country a few years ago through his promotion of a so-called process for extracting gold from sea water, is, according to a story received in Boston lately, teaching school in Manila. Jernegan organized the Electrolytic Marine Salts Company and attempted to dispose of 10,000,000 shares of stock at $1 per share. It is stated that he sold about $700,000 worth of the stock, $338,000 of which he reserved for himself. He disappeared in the summer of 1898 and after his departure it was discovered that his method of extracting gold from the sea was by secretly substituting gold impregnated mercury for pure mercury in a machine lowered from a wharf at Lubec, Me. A diver was sent down at night and placed the mixture in the machine. When the gold had been extracted from the mercury, it was cast into bricks and forwarded to Boston to be admired by stockholders. After Jernegan left America he appeared in Vienna and returned $85,000 to his victims.

Electric Power Distribution.

At the recent annual meeting of the Society of Naval Architects and Marine Engineers, Mr. W. M. McFarland, acting vice-president of the Westinghouse Electric & Manufacturing Company, read a paper entitled "Electricity in Manufacturing Plants," in which the advantages of the electric drive are cogently set forth.

In considering the subject of individual driving, Mr. McFarland says that while considered alone and for the individual tool, the individual drive is ideal; yet the objection will occur to any practical man that the enormous multiplication of small motors means increased complication and greatly increased cost. He believes that the judgment of more conservative engineers is favorable to individual driving where the power will be, say, from 5 to 10 hp and upwards, and for group driving where the tools require less than these amounts. In any large plant there are numerous small tools, such as drill presses, screw-cutting machines, light lathes, etc., which are in any case located together, and where it is perfectly easy to drive them as a group. The average power required for such a group will be quite uniform, and when they are group-driven a moderate-sized motor, with its relatively high efficiency, can be used with a fairly steady load, thus contributing to the efficiency of the general system, as well as of the particular group, and materially reducing the first cost of the installation.

One case which Mr. McFarland mentions where individual driving is obviously a necessity is that of portable tools, and the electric drive has made it possible to use portable tools on a scale that was previously unthought of. As the individual parts of machinery have increased in size in recent years, there has been more and more a tendency to take the tool to the work rather than the work to the tool. Indeed, in many cases careful investigation has shown that the time spent in setting these large pieces of work ready for the different tools to operate upon them was actually longer than the time occupied in useful work. In several large establishments in the country, including the Westinghouse works, which latter, it is believed, has the largest example at present, a section of the largest erecting bay has a floor which is a huge bedplate, practically the same as the table of a planer very much enlarged. This is carefully leveled and supported on massive concrete foundations. The portable tools, slotters, boring mills and milling machines are made with heavy frames having large flat bases made perfectly true. The result is that the tools will work either exactly perpendicular or exactly at right angles to the floor plate. In the Westinghouse works, however, as an application of the most advanced system of laying out work, a special form of surveyor's transit is used, and it is determined when the tool is brought up to the work whether it is in absolutely correct alignment or not, and if it is found at all out it is easily adjusted by wedges. The largest of these portable tools weighs twenty-five tons, a figure which would have been considered a very respectable one for stationary tool ten years ago. In some cases the motor can be readily stowed inside the frame of the tool, and in others it is attached outside.

Mr. McFarland expresses the opinion that if the induction motor had been the first to enter the field there probably would have been no room for argument concerning its merits for power distribution, as these are so great that there would have been little incentive to develop anything else. It happened, however, that although the alternating current was the first, as it is the natural product of any machine without special commutating devices, it was some time before a commercially practicable alternating-current motor appeared, and the direct-current motor, being first in the field and being undoubtedly meritorious, acquired the vogue which always comes to that with which people are familiar.

Mechanically the induction motor appeals at once to every practical man as the better device. The coils of wire are entirely stationary, while the rotating part consists of discs of sheet steel enclosed by massive composition end rings, which latter are connected by stout bars of copper bedded in slots in the steel sheets. The direct-current motor, on the contrary, has its coils movable as well as stationary, and, while these do not often give trouble, they are not so simple and mechanical as the rotating part of an induction motor. The direct-current motor has an additional feature which is entirely absent in the induction motor, the commutator and brush holder. These are the parts requiring most attention and the ones most liable to give trouble, although the modern methods of design and manufacture have reduced this to a minimum. The induction motor is about as simple as a grindstone or a pulley, because, as already stated, the rotating part is exceedingly strong and mechanical, and it has no connection, either electrical or mechanical, with the stationary part, except in the bearings, and as long as these are kept properly oiled there is no chance for trouble. The absence of a commutator does away with all danger of sparking, and hence renders it peculiarly adapted for use in such places as carpenter shops, powder mills and other places where sparking is absolutely inadmissible.

A very natural inquiry may at once arise from those not familiar with the subject, as to whether this great simplicity of the induction motor is not accompanied by a low efficiency. So far from this being the case, the efficiency of the induction motor is fully equal to that of the direct-current motor, and, indeed, is slightly better over most of the range of its capacity. Thus far it might seem that everything is so greatly in favor of the induction motor that there could be no room for choice; but the usual type has, from some points of view, one defect, namely, it is a constant-speed motor, and many of the foremost advocates of individual tool driving want a motor whose speed can be varied through a wide range. From this point of view the direct-current motor is superior, but the extent of the superiority depends almost entirely on the degree of importance which is attributed to securing variable speed from the motor itself without the intervention of belting or other mechanical means of varying the speed. It is entirely possible to make an induction motor whose speed can be varied, but in this case the extreme simplicity of the type is lost on account of the slip rings, which are used to enable the variable speed to be obtained by throwing resistance into the circuit. These, of course, while exceedingly simple and not so complicated or liable to derangement as the commutator of a direct-current machine, do add a slight additional complication. In the New York Shipbuilding Company and also in the steam engineering plant at the Brooklyn Navy Yard, the simplest type of induction motor is used, and the variable speed is obtained by means of belts and cone pulleys, which method is entirely satisfactory and gives an adequate range of speeds with extreme simplicity.

Another method of power distribution which has been used with decided success and simplicity is the three-wire system from a single generator in connection with field regulation, which enables the speed of the motor to be varied sufficiently to meet all practical purposes. The three-wire system is obtained by utilizing a special generator somewhat resembling a rotary converter; that is, in addition to the brushes and commutator furnishing direct current, leads are brought out from the armature winding to two or more slip rings placed upon the armature shaft. From these slip rings alternating current is taken, and if this is passed through an auto-transformer, and a lead is tapped from the middle of the transformer coil, this lead will always have a potential midway between that of the terminals on the direct side of the machine, thus securing at the motor two voltages, one equal to twice the other. By field regulation the speed can be varied through a ratio of about one to three, so that with this variation combined with the two voltages of the three-wire system we get a range of six speeds, which, in general, will be amply sufficient.

In the comparison of the two general classes of motors, one of the special advantages of the induction motor was not mentioned, namely, that from its construction there is no danger from a short circuit, because the bars in the rotating part are purposely short-circuited. Further, this motor will stand being brought to a full stop for a moment with the full current upon it without any resulting damage, while such an occurrence with a direct-current motor would certainly burn out the insulation, if not doing still greater damage. As a result of this it is not necessary to fit circuit-breakers or fuses to take care of these motors. In the small sizes the motor can be started up by simply closing the circuit by means of an ordinary switch, and in the larger sizes practically the same thing is done, as a two-throw switch is used in connection with an auto-starter, which is simply a small transformer arranged to give half the line voltage in starting up, the object being not so much the protection of the motor itself as to avoid the demand for a large amount of current from the generating system, as the starting current without the transformer would be somewhat more than twice full-load current. In the case of the direct-current motor it is, of course, necessary to start through the rheostat, so that the full voltage only comes on when the motor is up to speed.

While the electrical system of transmission secures a material re-

duction in the cost of power, this, after all, is not its greatest recommendation. The greatest benefit comes from the elasticity of the plant consequent upon its use. There is no longer any necessity for the rigidity of arrangement which obtains with shafting and belting, so that if it becomes necessary to rearrange the plant at any time the expense is reduced to a minimum. In the New York Shipbuilding Company's plant, for example, many of the tools being absolutely self-contained were not secured to foundations at all, and could be moved to any position desired, although these tools are not of the kind ordinarily considered as portable.

The paper gives the results of a test of the economy resulting from the substitution of electric for steam driving, made at the Westinghouse Air Brake Works, at Wilmerding, Pa. These works consist of a number of large detached buildings, and their old system of power transmission was from a separate boiler plant to individual small engines scattered about the various shops. Nearly five years ago they decided to install an electric drive consisting of alternating-current generators driven by Westinghouse-Parsons steam turbines, supplying induction motors.

There were originally a number of small steam engines which drove the tools on the group system, the engines being connected to moderate lengths of shafting. When the motors were introduced the number of groups was nearly doubled, this of itself being a decided improvement. The same boilers were used for the tests, which consisted of first running the shops several days and nights with the engines, and then for several days and nights with the motors. Both coal and water were carefully measured, and the saving as a result of the electric drive is about 32.5 per cent. Of course, it is not claimed that any such saving as this could be counted on in cases where the plant is relatively small and so disposed as to permit of the use of a very economical power plant driving well-designed and well-cared-for shafting. The actual saving in coal per day of twenty-four hours was about 40,000 pounds, or twenty short tons, and it will readily be seen that where coal costs $3.00 or $4.00 a ton this would mean a very respectable figure. The saving, however, did have a very marked effect from the fact that with the engines the capacity of the boiler plant had been about reached. As will be noted from the figures quoted, the reduction in steam consumption was about 30 per cent., which, of course, left a large reserve power in the boilers.

As to the best frequency for alternating-current power distribution, the paper states that a good deal depends on the extent of the plant and whether the lighting circuits are to be the same as the power circuits or not. For many reasons 25 cycles are most suitable for driving motors, but this is too low to give satisfactory service with arc lights, and also rather low for incandescent lamps. In such a case it may be desirable either to use an independent generator at 60 cycles, or perhaps a motor-generator set, or even to make the exciters large enough to supply direct current for lighting.

Accidents on Paris Underground.

It is reported from Paris that there were two accidents on the Metropolitan Electric Underground Railroad on November 30, somewhat similar to the great disaster of August 10, but there was no loss of life. In each case a car was burned between stations on account of short-circuit and the dry condition of the wood of the cars, causing the passengers to seek for escape along the tracks. As the accidents occurred in open stretches of track, the dense smoke escaped, and the dangers of suffocation were averted. The first reports had it that another disaster had occurred and much excitement was caused throughout the city.

Sun Spot Storms.

The recent remarkable magnetic storms have been freely attributed on good scientific authority to "sun spots," while various other terrestrial disturbances have been ascribed to the same remote origin. There seems no doubt of the fact that the presence of the sun spots is closely associated with the magnetic condition of the earth, and although many electrical storms are purely local, many of the great magnetic storms of the past half century have been found to coincide with sun spot periods. Profs. Young, Langley and Pickering are now cited as of the opinion that in this and other respects sun spots "don't count for much," at least, when it comes to disasters, for which they have been held responsible.

Novel Automatic Switchboard Telephone.

A new automatic telephone switchboard of the "mechanical operator" type has appeared in a patent of the issue of November 24, and notwithstanding the fact that it may probably never come into extended use, the method of carrying out the switching operations is sufficiently ingenious to merit fairly detailed explanation. Heretofore there has been but one example of this type of automatic switchboard in the design of which the inventor's chief object was apparently the abolition of electromagnets, the functions usually performed by these being transferred to most complicated mechanical devices. In this new switchboard no such extremely complicated devices are used, but means are resorted to which, though novel, may strike some people as almost as objectionable.

The whole system may be described best in reference to the diagrammatic drawings shown in Fig. 1, and by describing the completion and "taking down" of a connection. To this end, consider that the station shown at the upper right-hand corner desires communication with the station at the end of the line 200, passing out the left upper corner of the cut. Now, each subscriber is provided with a set of code stencils such as are shown in the upper middle of the cut, one such stencil being needed for each subscriber. Having selected the proper one and having inserted it in a slot in his selector device, he turns the crank, 27, of this latter and then releases it. At once the drum, 20, begins a slow rhythmic motion under control

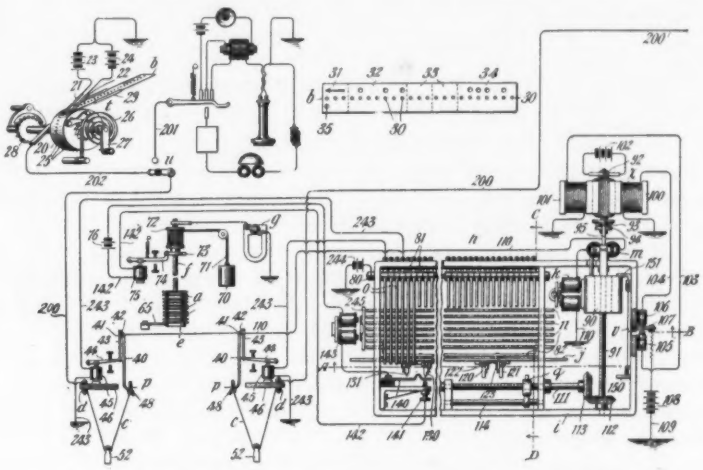


FIG. 1.—VANSIZE AUTOMATIC TELEPHONE SWITCHBOARD.

of the escapement, 28, the peripheral teeth of the drum feeding the stencil by engaging the middle row of holes. Two brushes connected to oppositely poled batteries, 23 and 24, trail the stencil contacting with the drum wherever a side perforation such as 35 appears.

Now, as the stencil begins its motion perforation 35 allows an impulse to be sent to the central office, this impulse reaching ground through plug *p*, its carriage, 40, and eventually the magnet, *m*, shown black. This magnet, *m*, is mounted upon the end of a carriage, 90, and travels therewith. The carriage, 90, is driven by a screw, 91, which passes through it. At *x* is shown an electric motor, the shaft of which engages the screw, 91, through a friction coupling sufficiently tight to revolve the screw and drive the carriage, 90, except when the armature of magnet *m* is dropped into a locking notch, 94, of the screw end of the coupling. The motor being in operation, say right-handedly, when our impulse arrives in magnet *m*, it at once starts the screw upon the magnet, the armature being lifted from the locking notch, and as this armature proceeds with the driven carriage it of course clears the notch on the fall following the cessation of the first current impulse.

There is a second magnet secured to carriage 90, and this is *k* in series with *m*. Now *k* responds to impulse of polarity opposite from those affecting *m*, and so, while *k* does not respond to battery 24, neither will *m* respond to battery 23, connected intermittently by perforations, 33. These impulses from battery 23 arrive in magnet *k* as this latter is proceeding across the ends of the series of bars *n*, and they are so timed in relation to the starting or first impulse, that certain of the bars, *n*, are translated in response to the magnet according to a predetermined code, exactly after the manner of the locking bars of a railway switch tower. The result is that by the time the carriage, 90, has proceeded to the limit of its forward

motion, the proper code for the desired number has been set, this code consisting of a continuous slot beneath that one of the sheet metal fingers, 81, connected to the desired subscriber's line.

This finger falls into the slot and thereby closes a circuit from battery 80, through magnet 45 of the connecting device. This magnet is one of a large circle of magnets, one for each subscriber, all connected to plug carriages so designed that any plug may be caused to strike in the center of the circle, exactly as the type bars of a typewriter strike a single position in response to their keys. The central striking point for the various plugs is at *e*, where there is a jack plate, *a*, waiting to receive the plug.

While all this has been going on, the carriage, 90, has struck the tapper, 150, and through the connected reversing switch has reversed the motor field to run the carriage back. Also has the nut, *q*, indirectly closed contact 140 to energize magnet 75, with the result that shaft *f* is permitted to revolve 180°, swinging the inserted plug away from point *e* and placing a second jack at *e*. Still another operation has taken place. Magnet 143 has restored all the bars, *n*, to the normal position.

As the screw, 90, continues motion in the reversed direction, a second set of impulses begin to arrive from battery 23. These set the bars *n* for the admission of the finger of the calling line, and just as for the called line, so will the plug of the calling line be inserted in the jack now at *e*. However, as the shaft, *f*, makes its second rotation of one-half turn, the bottom circular jack plate becomes released from its shaft and falls to a plate not shown in the figure, but lying just below the horizontal plane of the plugs, thereby leaving a new jack plate at the end of shaft *f* ready for the next connection.

Before proceeding to the method of disconnecting we must go back a step to observe the manner of signaling. A grounded generator, *g*, is shown connected to shaft *f*. This, of course, sends current out to the called line the instant its plug touches the jack plate, *a*. As soon as the second plug touches the jack plate of course the calling party is rung to signify "connection completed."

Now for the disconnection. The stationary plate upon which the jack plates fall is heated by a gas flame playing against its under surface. This, of course, heats the jack plates lying upon it and by a peculiar construction of the jacks causes them to release both plugs after a pre-determined time of conversation. This peculiar construction of jack embraces a pair of springs held closed against their normal tension by means of a fusible wax globule, which melts at the proper time.

This disconnection scheme will be regarded by some as most inadequate, for no provision is made to keep successive jack plates from falling upon each other and becoming insulated, thermally, from the hot plate. Another bad feature, from the telephone man's standpoint, is the liability of running out of jack plates. Mr. W. B. Vansize, of New York City, well known as an inventor and patent attorney, is the inventor of this machine.

New Telephone Patents.

NEW SWITCHBOARDS.

Two new switchboard patents have recently appeared, the one aiming to do away with connecting cords and plugs and the second to use them even to a greater extent than customary. The first of these patents is granted to Isidor Kitsee, of Philadelphia, while the second is granted to C. S. Exley, of Iowa. In Mr. Kitsee's switchboard a combined jack and plug is used with a dummy hand plug to move the connecting plug within its jack. Behind the jacks are arranged a series of conducting plates serving as connectors. These are adapted to take positions such that the two plugs for any connection will always select the first one not in use. In carrying out his invention Mr. Kitsee has embodied so much apparatus that it is doubtful if it can be turned to any practical use.

In Mr. Exley's switchboard each subscriber's line terminates in a cord and plug. The plug is normally kept in a jack to which the line drop is wired. Pairs of connected jacks serve as connecting circuits. The fact that the cord is usually the most vulnerable part of the switchboard counts against this system, as subscribers would be cut from service too often by defective cords.

RECEIVER FOR USE IN WIRELESS TELEPHONY.

A receiver for use in the wireless transmission of both telegraph signals and articulate sounds based upon the principle of the capillary electrometer has been patented by Andrew Plecher, of Bristow, Va. One form of this apparatus is shown in Fig. 1, in which wire 1 is the receiving wire to be connected at will to electrometer *O* or electrometer *R*. As may be readily seen, if the filament of mercury in electrometer *O* rises sufficiently it will close the local bell circuit. On the other hand, if the filaments of electrometer *R* rise, raising thereby the surface of the mercury in the bulb, the diaphragm, *R'*, will respond to the increased air pressure beneath it, and its vibration will be heard at the ear tubes. Now capillary electrometers can be designed to respond with promptness to almost infinitesimal changes of potential, and we, therefore, have at once a sensitive receiver. The inventor prefers as his lower electrode a small quantity of mercury within the vessel containing the electrolyte. He states that the preferred electrolyte is a solution of potassium cyanide with one per cent. of silver cyanide and 10 per cent. of potassium hydrate.

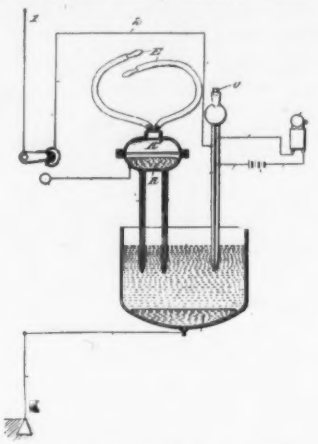


FIG. 1.—PLECHER WIRELESS TELEGRAPH OR TELEPHONE RECEIVER.

COIL TERMINAL.

The difficulty of securing terminals in coil heads in a manner such that they will not loosen in response to heat conducted from a soldering iron, is well known to telephone men. Many types of terminal have been tried, but all seem to have this failing. The next best thing to having a terminal that will not loosen is to have one, the loosening of which will be of no moment. Such a terminal is described in a patent issued to Richard Varley and assigned to the Varley Duplex Magnet Company. This terminal is simplicity itself and its construction is amply evident from Fig. 2.

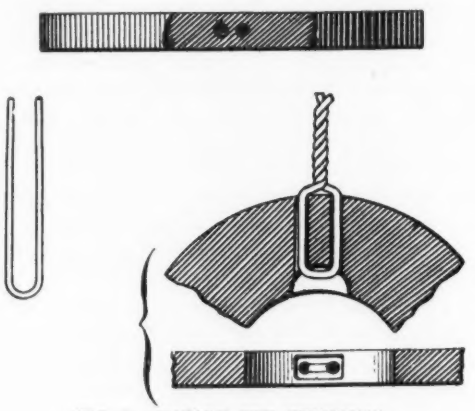


FIG. 2.—VARLEY COIL TERMINAL.

ALTERNATING-CURRENT TELEPHONE.

The above seems a rather curious title for a patent, as surely all telephones are alternating-current apparatus. What the inventor has to describe is a transmitter producing alternating currents in the induction coil primary, or better primaries, for two induction coils are used. Two diaphragms are also used attached by tension rods to a lever, so that the amplitude vibration of the diaphragm will be multiplied at the microphonic contacts situate at the extremities of the lever. The arrangement of primary circuit with reversed battery and duplicate transmitter buttons is that well known, the novel feature consisting in the insertion of two pairs of microphonic contacts in the secondary circuit. These are so wired to the induction coil secondary circuits as to accentuate the effect of that coil responding to an increased primary current and thus tending to prevent confusion from the superposition upon the secondary or receiver

circuit of impulses of opposite polarity. Fig. 3 shows the arrangement of parts *A A*, being the line or receiver wires. Andrew Plecher, of Bristow, Va., is the patentee of this device.

MISCELLANEOUS TELEPHONE ACCESSORIES.

The remaining patents for consideration include various telephone

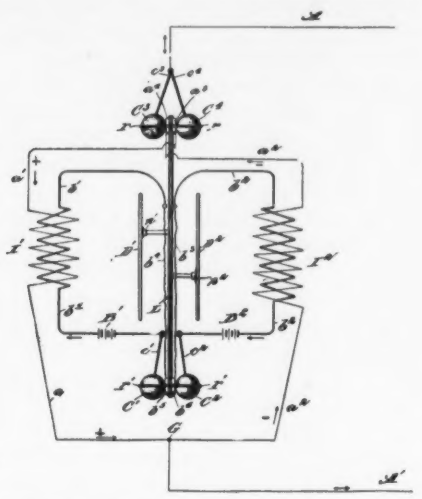


FIG. 3.—PLECHER ALTERNATING-CURRENT TELEPHONE.

appliances. One describes a parallelogram transmitter arm such that the diaphragm always remains vertical or in the position of maximum efficiency. This is the invention of A. Gamache, of East Clifton, Canada. A second is a further development of J. D. Peachey's burglar alarm attachment. The improvement over the arrangement described by us some weeks ago seems to lie in forming the weight which draws the receiver from the hook, so that it may be used as a box for the alarm bell, which both the central office operator and the house owner hear.

An electric cut-out, the invention of S. W. Miller, of Rochester, an electromagnetic switching device, and a writing pad for use with desk stand sets; this, the invention of G. M. Urie and A. A. Markam, complete the list.

Chicago Independent Telephone Convention.

Plans are being made actively in Chicago for the convention there next week of the Interstate Independent Telephone Association. The headquarters will be at the Auditorium. The officers of the Association are: C. E. Hull, president, Salem, Ill.; I. A. Frazer, vice-president, Connersville, Ind.; E. M. Coleman, secretary, Louisville, Ky.; J. W. Layne, treasurer, Carthage, Mo.; C. E. Tripp, Auditorium, has charge of exhibit space. The programme which has already been announced is as follows: Tuesday Morning, December 8, 9 to 12—Reception of members and friends by the Executive Committee and officers at the secretary's headquarters. Tuesday Afternoon, December 8, 2 to 5—Address of welcome, Hon. Carter H. Harrison, Mayor of Chicago. Response and annual address by president, Senator C. E. Hull, Salem, Ill. Report of the secretary. Report of the treasurer. Selection of Executive Board. Selection of Nominating Committee. Revision of Constitution and By-Laws. Adjournment. Wednesday Morning, December 9—The officers and Executive Board will take charge of the delegates this morning from 9 to 12 in visiting exhibits. Wednesday Afternoon, December 9, 2 to 5—"Should the Territory of the Interstate Independent Telephone Association Be Enlarged, and if so, Why?" Hon. John Van Nortwick, Appleton, Wis. Discussion. "Are Our Telephone Periodicals Sufficiently Careful as to the Business Relations Sustained by Contributors?" W. H. McDonough, New York City. Discussion. "Standardization of Apparatus," Prof. J. C. Kelsey, Purdue University. Discussion. "Standardization of Construction," W. C. Polk, Kansas City, Mo. Discussion. "Competition between Independent Companies and Farmers' Mutuals," O. Rex, North Manchester, Ind. Discussion. Thursday Morning, December 10, 9 to 12—"Independent Toll Line Systems, and Is the Time Ripe for Merging?" J. S. Bailey, Jr., Toledo, Ohio. Discussion. "Where Should the Line of Demarcation Be Drawn between Independent Operating and Manufacturing Companies, and the Bell Company?" Hon. Henry A. Barnhart, Rochester, Ind. Discussion. "What Should Be the Representation in the Connection of the Interstate Independent Telephone Association in Voting?" Mr. Prewitt, Winchester, Ky. Discussion. "Who is Who? What Are the True Ear Marks?" Hon. Theodore Gary, Macon, Mo. Discussion. Election of officers. Thursday Afternoon, December 10, 2 o'clock on. Officers and Executive Board will entertain the delegates. A banquet is to take place during the week.

Coming Chicago Meetings of the A. I. E. E.

The Executive Committee of the Chicago branch of the American Institute of Electrical Engineers has arranged for a meeting to be held at the rooms of the Western Society of Engineers Tuesday night, December 8, at which time Prof. W. E. Goldsborough, chief of electrical exhibits of the Louisiana Purchase Exposition, will deliver an address on the electrical features of the St. Louis World's Fair. Another distinctively Chicago meeting, which will be held some time during the winter, is to be devoted to automatic telephone exchanges, a subject which is of particular interest just now in view of the inauguration of the new automatic telephone exchange service in Chicago, Dayton, Ohio, and Grand Rapids, Mich. Papers have been partially arranged which will take up the engineering details of the automatic telephone exchange as it exists to-day and also a broad engineering consideration and analysis of the subject of automatic as compared with manual exchange systems. Chicago has abundant telephone engineering talent to have an excellent telephone meeting of this kind, and as every effort will be made to have the subject considered as far as possible from the engineering standpoint without commercial prejudice, there seem to be good prospects for a substantial addition to the fund of information as a result of the meeting. The Chicago branch will probably hold a number of other meetings during the year for the discussion of subjects taken up at the New York meetings when the subjects are of such a nature as to be of interest to Chicago members.

CURRENT NEWS AND NOTES.

AMERICAN ELECTROCHEMICAL SOCIETY.—The next general meeting of the American Electrochemical Society will be held in Washington, D. C., April 7, 8 and 9, 1904.

ELECTRIC SMELTING PATENTS.—It is stated that following the recent decision sustaining the Bradley electric smelting patents, an understanding has been arrived at between the Pittsburg Reduction Company and the Electric Smelting & Aluminum Company, the owners of the Bradley patent, whereby the former will be licensed to manufacture aluminum under these patents. This arrangement included a settlement for past royalties and also with respect to litigation involving the Hall patents, which had been decided in favor of the Pittsburg Reduction Company, and later reopened.

LARGE WESTINGHOUSE TURBINES AND GAS ENGINE.—There are now in process of construction at the works of the Westinghouse Machine Company several 5,000-kw steam turbines and a 3,000-hp gas engine. The former are being built for use in the New York and Pennsylvania tunnel plant and in the power house of the Philadelphia Rapid Transit Company. The turbo-generators will supply three-phase current at 25 cycles and 13,000 volts, the speed being 750 r.p.m. The gas engine will have two sets of tandem cylinders with pistons connected to cranks displaced 180°. Each cylinder will be double-acting, the crank effort thus corresponding to that of a double-cylinder steam engine.

NEW YEAR GREETINGS.—At midnight on December 31, 1902, the United States Naval Observatory flashed an instantaneous New Year's greeting throughout the country by means of a system of signals. On January 1 next, at the exact second of the beginning of 1904, Washington time will be flashed by the observatory to all points in the world having the necessary telegraphic connections, if the permission and cooperation of foreign Governments, which have been asked for, can be secured. The connections will include North, Central and South America, Europe, Asia, Africa, Australia, the Philippines and all the insular possessions of the United States, with the exception of Samoa. The time necessary to transmit the signal will be accurately taken by every station to which it is to be sent. Last New Year's the signal traveled more than 3,000 miles in six one-hundredths of a second.

THE SOCIETY OF MEXICAN ELECTRICAL ENGINEERS has been organized in the City of Mexico. The officers are: President, Roberto Jofre; vice-president, Luis A. Lavie; treasurer, Teodulo Baz; secretary, Manuel Gallegos.

CAPE TOWN INDUSTRIAL EXHIBITION.—An exhibition with this title is to be held at Cape Town, South Africa, in November and December, 1904, and January, 1905, under distinguished auspices. The site is Green Point Common. The London offices are at Palmerston House, Old Broad Street. Space is $1.25 per square foot. The grounds are to be lighted by electricity and a plant will be put in for that purpose.

A "DEAD" MAN BROUGHT TO LIFE.—A partly successful attempt was recently made at Cleveland to resuscitate a man who had been electrocuted by a live wire. Adrenalin was administered by three physicians after the man had been "dead" three hours. Within fifteen minutes his heart beat slightly and the blood began to course through his body. Shortly after, however, all signs of life disappeared. The doctors state that had they begun their experiment two hours earlier they would have been successful.

DE FOREST IN ENGLAND.—A cable dispatch from London, of November 28, says: The experiments with the De Forest wireless telegraphy system were carried out to the entire satisfaction of the British postal representatives this week across the Irish Sea, between Howth and Holyhead, a distance of sixty-four miles. Messages were transmitted at the rate of thirty and thirty-five words a minute, the replies being received quicker than by the ordinary telegraph. Although a Marconi station was close to the De Forest installation at Holyhead, there was no noticeable interference with the messages.

NEW YORK ELECTRICAL TRADES SOCIETY.—The eighth annual meeting of the Electrical Trades Society of New York will be held on Tuesday, December 8, at Muschenheim's Arena, No. 41 West Thirty-first Street, New York, at 6 o'clock P.M. There will be reports read, addresses and the regular election of officers. An informal dinner (business dress) will follow the annual meeting, at 7:30 P. M. Dinner tickets, two dollars each. Mr. Avery P. Eckert, the secretary, requests that he be promptly notified by any one who proposes to be present at the dinner, which promises to be a very enjoyable affair.

N. E. L. A. PHOTOMETRICS.—In regard to the abstract issued by the National Electric Light Association and noted already in these columns, pertaining to photometric work, Prof. C. P. Matthews writes us: "In the abstract of the fourth progress report of the committee on photometric values of arc lamps, of the National Electric Light Association, an unfortunate clerical error appears in the matter of the relation of candle-power to voltage in the single-glower Nernst lamp. In the sentence: 'A special test given in the report shows that a change of 1 per cent. in the voltage makes in this particular case a change of more than 14 per cent. in the candle-power.' Value should be 6.38 per cent."

THE NATIONAL ELECTRIC LIGHT ASSOCIATION has had so many requests from non-members for the report of the Chicago meeting now in press, that, owing to the distribution having been unavoidably delayed until the year is nearly ended, it has been decided to present a copy of this book to all companies making application for membership for the year 1904, provided their applications are received before the end of this year. A number of applications have already been received on this basis, and there is every indication of a large increase in membership within the month remaining. A copy of the recent valuable report of rates for lighting and power will also be sent to new members. It is suggested that companies intending to join make early application, as both editions are necessarily limited, and are likely to be soon exhausted.

NEW YORK ELECTRICAL SOCIETY.—The Society had an excellent meeting on Monday, November 30, when Mr. W. D'A. Ryan, of the General Electric Company, delivered an admirable address on "Practical Problems in Lighting and Illumination." President Carty was in the chair, and over two hundred members were present, the lecture being delivered at the Hebrew Technical Institute, to which the society was very cordially welcomed by Mr. L. B. Marks, in behalf of the trustees. The room was beautifully illuminated with the aid of the Ryan diffuser and enclosed arcs. The lecture dealt broadly with questions of light distribution for various purposes and the merits or demerits of the different kinds and forms of light; and offered many valuable and pertinent suggestions, that were eagerly caught up. The lecture, which was accompanied by many skillful experiments and demonstrations was kindly repeated by Mr. Ryan the next day, for the express benefit of the 250 youthful students of the Institute.

TELEPHONE SUBSCRIBERS' LISTS.—In an interesting article on the subject of "Mail Advertising," Mr. J. N. P. Cramer is quoted in *Printers' Ink* as bearing testimony to the value for such purposes of the lists of telephone subscribers in rural districts: "Some of the little independent lines built by farmers for their own communities are only fifteen miles long. They have perhaps 100 subscribers. The subscribers' list of such a line gives names that have been hard to get heretofore, as they are in no directory. The rural telephone sorts out the influential classes in every community, and lists of names made up from telephones are excellent for high-class propositions. I should call such names the very best that could be secured for investment advertising. So far as I know we are first to compile such a list. We began a few months ago. The telephone directories have been difficult to get and have cost us a pretty penny. We now have 50,000 names in New England, 150,000 in New York, 20,000 in New Jersey, 80,000 in Pennsylvania, 100,000 in Ohio and 200,000 in other eastern States."

SUN SPOTS, SHOWERS, SHOCKS.—The Abbé Moreux, director of the Bourges Observatory, has written a letter to the *Paris Temps*, in which he attributes the phenomena noted to the sun spots. He says: "Already this year, on March 26 and 27, there were magnetic disturbances which I had predicted. During their activity sun spots are accompanied by aurora borealis, magnetic derangements, deviations of the compass, seismic movements and earthquakes. We are now traversing a maximum period of sun spots, such a period as recurs but once in every thirty-three or thirty-five years. This maximum will continue for about two years, during 1904 and 1905, and we must expect more frequent aurora borealis, great magnetic disturbances, earthquakes over vast areas and numerous explosions of firedamp in the mines. Moreover, the solar activity will far surpass the point attained at the last maximum period of sun spots, in 1893, and with this augmentation of solar heat evaporation from the ocean will be greater. In consequence we are going to have a rainy period lasting perhaps up to 1912."

ATMOSPHERIC NITROGEN FIXATION.—United States Consul-General F. H. Mason writes from Berlin as follows: "The gradual but ultimately inevitable exhaustion of the known nitrate deposits of South America lends a growing interest to the methods which have been devised for obtaining a supply of nitrogen for fertilizing purposes from the inexhaustible storehouse of the air. That this can be done as a scientific process has long been known. The first method was by passing a current of air over red-heated copper, whereby the oxygen combined with the metal to form oxide of copper, leaving the nitrogen free. At first the nitrogen thus produced was fixed by combination with calcium carbide to form nitrate of lime (Kalkstickstoff) or calcium cyanimide, a combination of lime, carbon and nitrogen, which had all the essential properties of a nitrate fertilizer. But as the use of calcium carbide rendered the product unduly expensive, a method was sought which would employ a substitute for that material, and this was found by Dr. Erlwein, who brought the nitrogen into combination with a mixture of powdered charcoal and lime in an electric furnace. The product of this combination is a black substance containing, besides the lime and carbon, 10 to 15 per cent. of nitrogen, in perfect condition to be used as a fertilizer. From the experiments thus far made with this new artificial nitrate—which is known in commerce as calcium cyanimide—it appears that its nitrogen acts upon plants quite as effectively as that contained in a proportionate quantity of nitrate of potassium or sodium nitrate (Chile saltpeter). The scientific problem of obtaining nitrogen for fertilizing purposes from the atmosphere would seem, therefore, to be satisfactorily solved. Whether it can be done on a very large scale and at a cost which will make it economically available for general agricultural purposes remains to be demonstrated by practical experience."

HOSPITAL TROLLEY CAR.—At Utica, N. Y., last week, a special trolley car was run over the street-car line from Mohawk village to convey a hydrophobia patient to the hospital.

WISCONSIN WATER POWER.—The United States Geological Survey has just completed an investigation of available water powers along the Chippewa River between Chippewa Falls and Flambeau, Wisconsin, and finds that in this distance of about 42 miles there is a total fall of 243 feet. Only a small part of this is used. The Chippewa Falls Lumber and Boom Company has a plant at the Falls which develops about one-third of the available 7,000 hp. Another company is now at work developing the power at Jim Falls, where there is a head of 33 ft. Points at which there are excellent chances for development are Eagle Rapids, with a 30-ft. drop; Brunne Falls, a fine site for a dam, with about the same head, and Point Creek Rapids, Coltons Rapids, and Chevally Rapids, each with 5-ft. fall. The field work of the Survey was done by Mr. F. T. Fitch, who made a complete map of the river, showing all the islands, rapids and falls, noting at the same time the exact height of the water at the top and the bottom of each fall.

FIRE ALARM SYSTEM.—To Mr. A. J. Woodworth, of Sparrows Point, Md., is to be credited a fire alarm system just patented which is going beyond the ordinary devices and appliances, includes means for operating detonators so as to arouse a whole community where no regular fire service exists. The second claim reads: "In an alarm system, a normally closed outer circuit including a relay, alarm boxes in said outer circuit, normally open primary and secondary inner circuits, means for closing the inner circuits when the outer circuit is opened, a solenoid having a movable core in the secondary inner circuit, means operated by the movement of said core in one direction for instituting the sounding of the detonator and means operated by the movement of the core in the opposite direction for stopping the sounding of the detonator upon the sounding of the detonator, and means operated by the movement of the core in the opposite direction for stopping the sounding of the detonator upon the energization and deenergization, respectively, of said detonator-actuating solenoid.

ELECTRICALLY-HEATED HANDLE.—Mr. R. A. Fliess, a young electrical engineer who has for some time past given special attention to automobiles and storage battery work, has taken out a patent on an ingenious little device for heating handles electrically. Anybody who has ever manipulated an automobile knows how numb and deadened the hands will become in cold weather; and this is true, moreover, of other handles to be worked in the open air. The Fliess handle comprises an electrical conductor forming a heating device, and a core made of a bad conductor of heat located inside the heating section, the outer surface of the core being glazed or polished to reflect the heat outwardly. Such a core would be, for example, porcelain with annular ribs and spaced apertures, enclosed by German silver wire as the conductor. The current supply is, of course, readily drawn from the batteries and a small supply suffices to keep the fingers comfortably warm.

SHARPENING RAZORS.—Mr. Theron Davis, of New York, has patented a plan for sharpening edged tools in a magnetic fashion and illustrates the idea as applied to razors. It is a well-known fact that when examined under a microscope the finest edge will appear as a succession of somewhat ragged teeth. Now, when these teeth are in proper alignment the edge is in condition to do good work, and if the infinitesimal teeth are laterally or otherwise displaced the result is what we call "dullness." The invention affords a simple device which can be applied to any razor or other edged tool and which when in position will by magnetic attraction cause the particles constituting the edge of the tool to turn into the proper alignment for the best cutting. Mr. Davis has found that because of the tendency of magnets to draw to the poles, where a magnet is applied to a cutting edge that is held opposite the poles the tendency is to improve only parts of the edge; but by magnetizing an edged tool and then holding a bar of soft iron or other attractive matter opposite the edge the magnetic attraction is exerted all along the edge, and so a uniform sharpening is obtained.

ELECTRIC POWER IN FRANCE.—Discussing hydro-electric development in France, Mr. J. C. Covert, United States Consul at Lyons, France, says: "France is a country where a large aggregate industry is carried on by individuals in their families, and an effort is being made to furnish these classes with electrical power in their households. It is backed by heavy property owners who feared that the application of steam or electricity in large factories would deprive them of tenants, and they have leased electrical appliances to their tenants, to be paid for by easy installments. In Lyons one of the most populous quarters of the city would be entirely deserted if the weavers could not enjoy the advantages of electrical power in their competition with steam-impelled machinery. In the Department of the Puy-de-Dôme, around the city of Thiers, in the neighborhood of a small stream—the Dore—hundreds of families have small outfits of machinery, with which they make knives. Upon the first proposition to erect a large factory to replace these little family establishments some enterprising men in the neighborhood, moved by philanthropy and the desire to prevent the industry from moving to other quarters, set to work to secure electrical power for the community, and now their machinery is run by electricity brought from a distance of from 50 to 75 km (31 to 46 miles). The manufacture of silks and velvets by steam-propelled machinery in France has driven the hand loom out of thousands of households in Lyons, notwithstanding the struggle to introduce electrical power into family service. The looms have been transferred to the country into farm houses, where they can be utilized in the winter and in weather unseasonable for out-of-door work. In farm houses for a distance of 100 miles around Lyons men, women and children put in their odd hours at work on a loom, generally manufacturing cheap mousselines and the finest of silk velvets. It is proposed to connect many of these isolated looms with a current of electricity, thus introducing power, light and heat into the poorest households of the country."

CONTROL OF ELECTRIC MOTORS.—Mr. Arthur C. Eastwood, of Cleveland, Ohio, has worked out and patented a method to limit the torque transmitted by a motor so as to avoid strain on the receiving apparatus or structure, as well as to arrest the motion of a load operated upon while permitting the armature of the driving motor to continue in rotation and furnish the predetermined maximum torque. An illustration would be the operation of ore buckets, say with a driving and a clutch motor. For example, considering the driving motor to be in operation, its armature will turn the revoluble field frame of the clutch motor around its armature, and such action will generate current in the armature, which current will react with the revolving field frame, so as to cause the armature itself to revolve in the same direction as the field frame, though it will lag behind it by an amount sufficient to generate the necessary current to keep the load connected to it in motion. The current thus generated passes through the separate field winding of the driving motor, and as the load increases, so as to cause the armature to lag behind the field by a greater amount, the current generated will increase in magnitude, still further strengthening the field of the driving motor. As a result the armature of the driving motor is caused to slow down, as is also the rotating field frame of the clutch motor. The further increase of the load continues to increase the amount of slip between the armature and field of the clutch motor until finally a point is reached where the field member will just represent the requisite amount of the slip. In such case the speed of the armature of the motor will be zero, and the load will be at rest. It will be thus seen that when a certain critical load is reached the armature of the clutch member will come to rest while, however, the field frame is still being rotated, though at a comparatively low speed, by the driving motor. The clutch motor will thus be acting as a generator, and the current generated will be limited in amount by the resistance of the armature, the connections and the separate series field winding of the driving motor, together with an adjusting resistance. This maximum or critical current may be varied by varying the amount of this adjusting resistance, which, however, will not require changing after once being fixed so as to limit the current to a predetermined amperage. In the meantime the driving motor will require from the supply mains just sufficient current to compensate for the loss in the system and to hold the load from slipping, so that although the clutch motor acting as a generator will be delivering its maximum current when its armature is stalled the amount of energy required from the line will as a whole be quite small, since said current from the clutch motor is at a very low voltage, just sufficient to force it through the resistance of the armature, connections, separate field winding, and fixed resistance.

LETTER TO THE EDITORS.

Choice of Wattmeters.

To the Editors of Electrical World and Engineer:

SIRS:—Referring to the article by the undersigned in ELECTRICAL WORLD AND ENGINEER, dated November 21, I would direct attention to the fact that the editorial on the subject of this article on page 828 is rather unfortunately worded when it states that "The meter which has the largest driving torque per watt, and the largest full load torque will be the meter which is less likely to retard seriously at light load through undue mechanical friction." This is entirely opposed to one of the points brought out in the article, which states that "It is only by keeping the moving parts as light as possible and the torque relatively high that the best results are obtained."

Thus your editorial would have been more nearly in line with the writer's meaning if it had stated that "The meter which has the largest driving torque per unit weight of movement, providing this weight is not excessive, will be the meter which is least likely to retard seriously at light load through mechanical friction."

NEWARK, N. J. PAUL MACGAHAN.

DIGEST OF CURRENT ELECTRICAL LITERATURE.

DYNAMOS, MOTORS AND TRANSFORMERS.

Compounding of Alternating-Current Generators.—HEYLAND.—An article in which the author gives the theory of his new system of compound synchronous machines which has been evolved from his older method for compounding non-synchronous machines. Machines of this new synchronous type have already been built by Kolben. The author shows that the behavior of his new machine may be represented by diagrams quite similar to those for the non-synchronous machine. The new generators are ordinarily synchronous machines, of the well-known type with stationary armature and revolving pole system, and may be imagined to have been evolved from his former non-synchronous machines by assuming that the rotor is provided with a single phase (instead of polyphase) winding. It is then possible to go a step further and replace the non-synchronous rotor by a pole wheel, the single-phase winding by a pole winding. This pole winding is distinguished from an ordinary pole winding only in so far as it consists of several wires in parallel and is connected in a corresponding way to a commutator to which the exciting and compounding current is directly supplied as single or polyphase alternating current. The author first discusses the compound machine. In the same manner as it is done with the non-synchronous machine, the commutator is supplied with the exciting end load current. From the diagrams developed it is concluded that the compounding is just as perfect as in the non-synchronous machine. This result is said to be confirmed by Kolben's tests. The author then discusses the method of self-excitation of these machines without compounding. Direct shunt excitation is used with alternating currents, the brushes being set in an advanced position. It is then possible to insure that for a load with a phase difference below a certain limit there is no voltage drop. The voltage remains approximately constant and even increases slightly with increasing load. Besides this voltage regulation, these machines have all other practical advantages, especially the saving in material in common with the compound machine and are even simpler than the latter because there is no compounding transformer. As generators they render exactly the same service, for instance, in the case of existing plants which already have a good regulation of voltage, or in the case of larger central stations in which the variations of voltage are generally slight.—*Elek. Zeit.*, November 5.

Speed Regulation of Direct-Current Motors.—BROADBENT.—An article in which the author claims there is a tendency in the American technical press to overesteem the point of speed control for ordinary work, and to boom special systems. A recent article of Hemingway (ELECTRICAL WORLD AND ENGINEER, October 3) is quoted, in which the variation of magnetic density of the field magnets is made use of. The present author thinks that such machinery would be too expensive. Multiple voltage and similar systems, although probably not increasing the cost of the motor itself, increase the cost of the installation as a whole, as well as the cost of upkeep. He points out that simplicity has a commercial value and that standard motors can be bought in the open market in England in which a speed regulation of 2 to 1 can be obtained by means of a shunt rheostat control; nor is there any difficulty, apparently, in obtaining the ratio of 3 to 1 by the same means. This method he thinks will be satisfactory for general work.—Lond. *Elec. Rev.*, November 13.

REFERENCE.

Compensated Series Motor.—OSNOS.—A theoretical article illustrated by diagrams. Of all single-phase commutator motors, known at present, the compensated motor may be the most interesting one. In the bipolar type it has two pairs of brushes. One pair of brushes is connected in series with the stator winding (as in the ordinary series motor) and a line which would connect them is perpendicular upon the axle of the stator winding. The other pair is short-circuited in the direction of the axle of the stator winding. The author first gives a graphical theory of this motor. Among the various results, derived by him, is the following on the influence of the air-gap. For the same phase difference and under otherwise identical conditions, the number of revolutions of the motor must be the larger, the greater the air-gap. Reversely, for the same number of revolutions and under otherwise identical conditions, the primary phase difference is the greater, the greater the air-gap. The article closes with the development of the analytical formulas of the motor. —*Elek. Zeit.*, November 12.

POWER.

Drainage by Electricity.—An account of an electric power transmission scheme in connection with a drainage and sewage disposal system near Birmingham. Two steam generators, aggregating about 175 hp, will generate 2,300-volt, three-phase currents of a frequency of 50, which will be transmitted over the overhead transmission line, 5 miles in length, and will be tapped at eight points along the route, at each of which a small sub-station will be erected, containing step-down transformers for reducing the pressure to 200 volts. At four sub-stations centrifugal pumps, directly connected to induction motors, are to be installed for the purpose of pumping the water from the main culvert, running the whole length of the estate, on to the land. In all 14 motors ranging from 2 hp to 28 hp, are to be provided, and a number of them will drive farm machinery or machinery used in connection with the treatment of sewage.—Lond. *Elec.*, November 6.

Removing Water from Peat.—A note on a recent trial made in London with a new process for converting peat into the equivalent of coal of high calorific value. "Peat, said to contain 70 to 80 per cent. of water, was placed in a perforated cylinder, which was rotated so as to throw off free water. An electric current of 220 amp. at 200 volts was then passed through the peat, and this, according to a circular describing the process, generated heat of a particular kind, which drove off the remaining or latent water. We have been informed, however, that the action was an electrolytic one, the current splitting up the cell, driving off the latent water, and leaving all combustible material behind." Some inconsistencies in the claims of the inventors are pointed out.—Lond. *Elec.*, November 6.

TRACTION.

Single-Phase Traction.—A long editorial in which, after some notes on the Lamme and Finzi motors, the writer says that "a most simple solution of all the difficulties" has been found in the Eichberg and Winter motor, in use on the short Spindlersfelde road, near Berlin, already noticed in the Digest. "We have satisfied ourselves that the claims made for this motor are perfectly justified, but at present we are not at liberty to go into constructive details." In outward

appearance the motor does not differ materially from the well-known General Electric direct-current motor. The outside dimensions for any given power are practically identical. All the standard direct-current controlling apparatus, either of the ordinary series parallel or the multiple-unit type, including the automatic switches, which have proven so successful, are applicable to the alternating-current system, "the only difference being that, to all intents and purposes, there are no resistances, and that the number of controller contacts for giving variations in speed is less in the alternating than in the direct-current system." The power factor at normal speed is unity, and as that for the lowest starting speeds is very little below 0.8, the average power factor for the complete system will probably be in the neighborhood of 0.9, which is practically as good as what is now obtained where rotary converters are used. The efficiency is practically the same as that of an equivalent direct-current motor, and the average acceleration obtainable is quite as good, with the additional advantage that the rate is as nearly as possible uniform during the total period of acceleration, which is not the case with direct-current motors. The motor may easily be changed from a series to a shunt machine. The motors are so arranged that the commutator only takes a low-pressure current, the voltage of which, however, may be as high as 600 volts if desired. The high-pressure current need not pass through any transforming device, and its voltage, except for insulating reasons, can be raised as high as wished. Any frequency can be used as far as the motor is concerned. At present a frequency between 25 and 40 is used and has given perfect satisfaction. The writer is very enthusiastic concerning the future of the motor. "There is nothing of an experimental nature about it, and the controlling devices are identical with the well-known apparatus used in continuous-current traction. This discovery will mark a new era in the application of electricity to main lines, for the results so far obtained practically solve the traction problem. This, however, is not all, as the motor is so simple in construction and regulation and so versatile, that in the near future it should undoubtedly displace not only continuous-current motors, but all polyphase motors as well. Polyphase installations appear to be doomed, and we may even see a return to single-phase distribution at 25 or 50 cycles for all purposes."—Lond. *Elec. Rev.,* November 13.

Conestoga Traction Company.—An illustrated description of an extensive system of city, suburban and interurban lines extending throughout Lancaster County, Pennsylvania, and connecting Lancaster, Columbia and the other principal points in that section as well as furnishing local service. It comprises a large number of lines that were organized independently, but have gradually been consolidated into one general system. Recently a number of improvements have been undertaken, including the construction and equipment of a large power house, several sub-stations, and the rearrangement of the transmission and distribution system. The power house will contain three steam-driven, 1,000-kw alternators, which are of the engine type, with rotating field designed for operation at 25 cycles, three-phase, developing 1,000 kw at 7,500 volts under normal conditions. The current is used for lighting, power and railway work, the greater part of it, of course, being employed in the operation of the railway system. A separate building, entirely independent from the main power house, has been designed for housing the transformers, the lightning arresters and the high-tension apparatus. An underground tunnel between the main power house and this transformer station carries the cables from the switchboard to the transformers. In addition to the sub-stations at the principal points of distribution the company has fitted up a portable sub-station of 250-kw capacity with step-down converters, circuit-breakers and arresters, which can be utilized at any point on the road where there is an unusual demand for power.—*St. R'y Jour.,* November 7.

Tramway Sub-Station.—A description of a sub-station, designed to furnish power to cars operating between Kittery, York Beach and Dover, on the Portsmouth, Kittery & York Street Railway, and to act as an auxiliary to the existing station at Kittery Point, and in conjunction with the company's storage battery at Long Beach. Current is supplied to the sub-station at 10,000 volts over a three-phase transmission line. The equipment at the station comprises a 200-kw, twelve-pole, 550-volt, 60-cycle, three-phase rotary converter, running at 720 r.p.m., and three 76-kw stationary transformers with a two-panel switchboard. The primary voltage is 11,000 and the secondary 391. The transformers are oil-cooled, and are operated without oil switches.—*St. R'y Jour.,* November 7.

Ball Bearings for Tramway Motors.—A note on recent tests made by the Berlin tramway company with two tramway motors fitted with ball bearings. The results are said to have been so satisfactory that the company has decided to introduce such motors on a large scale and has given orders for 100 similar machines. Although by their adoption a saving in friction losses of about 1 per cent. is effected, the chief advantage of the ball bearings lies in the direction of economy in lubricants and the ease with which these are applied. The wear of the balls and ball races is said to be "very small."—Lond. *Elec.,* November 6.

REFERENCES.

Economy of Tramways and Electric Traction without Rails.—HECKER.—On the basis of statistical data the author had previously developed an empirical relation between the number of inhabitants in a district and car-kilometers per year, also a relation between the latter and the income. He now uses these relations to calculate tables which shall enable one to decide whether in a given district an electric tramway will pay, or only electric traction without rails or neither system.—*Elek. Anz.,* November 8.

Laying Tramway Rails.—SATTLER.—The first part of an article, illustrated by diagrams and giving some mechanical details of the method of laying tramway rails, especially with wood or asphalt pavement.—*Elek. Anz.,* November 15.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Spain.—BLUMENTHAL.—An article on electric central stations in Spain. On account of the scarcity of coal for making gas, only the largest cities are provided with gas works. Before the introduction of electric light, petroleum and oil were the chief illuminants in Spain. In recent years, however, electric light has come into very extensive use, not only in the houses of the more prosperous classes, but quite generally throughout the towns. There were installed 6,575 kw in 1880, 12,762 kw in 1890, 78,475 kw in 1901, and at present about 100,000 kw. This represents 5 watts per inhabitant. (In Germany 438,772 kw were installed in 1902, i. e., 7.5 watts per inhabitant.) There are about 1,000 central stations in Spain, and the development of electric lighting has been especially rapid in Madrid and Barcelona. In the larger cities the three-wire, direct-current system is mainly used with 220 volts between the outers, some plants using, however,

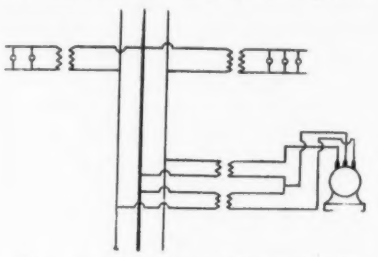


FIG. I.—TWO-PHASE DISTRIBUTION.

alternating current. In Madrid 16,600 kw of machines and 17,700 kw of storage batteries are installed, so that 66 watts are installed per inhabitant (against 48 watts per inhabitant in Berlin). Since 1890 the development of water power has steadily increased, alternating current being mostly generated and transmitted to a number of different towns. The keynote of all these installations is simplicity of arrangement. Nothing is installed that is not absolutely necessary. For instance, no attempt is made to keep the pressure at the consumers' terminals constant; the voltage in the station is maintained constant, so that the voltage at the lamps varies according to the load. For distribution the two-phase system (Fig. 1) is widely used, since it has the advantage that it can be resolved into two single-phase systems, so that the larger towns can be provided with two feeding points. Many mills have hydro-electric power plants, the current being used by them during the day for power purposes and sold in the evening to towns in the neighborhood. There are no meters in use. To control to some extent the current consumption by the customers, automatic circuit-breakers are often installed which interrupt the current when more than a certain number of lamps are lighted simultaneously. But these devices are mostly very ineffective and often do not break the circuit at even double the current for which they are set. The financial return of the electric stations are high, a dividend of 30 or 35 per cent. being nothing unusual. The methods of house wiring are very crude. Some high-tension transmission plants have recently been erected. Three such plants of the Hidroelectrica Iberica Company are in course of erection and

one, in which currents are generated at 30,000 volts, will soon be opened. A company has recently been formed to develop nearly all the water powers of the Province of Catalonia, with an aggregate of 100,000 hp. Municipal plants are nearly unknown in Spain, the stations being owned by private companies. Gas engine plants begin to find more and more favor. Electric traction is still largely undeveloped, although a few cities have extended networks of tramways. —*Elek. Zeit.*, November 5.

WIRES, WIRING AND CONDUITS.

REFERENCE.

Cables.—SCHMIDT.—The conclusion of his article in which he gives illustrated notes on the construction and manufacture of direct and alternating-current, low-tension cables and on recent progress in the manufacture of high-tension cables. The article is concluded by a table of cables made for 6,000 volts or more. Only seven German cable works are, however, considered. The list comprises 55 installations of cables, among them 16 for 10,000-volt, single-phase alternating current; 3 for 15,000-volt, single-phase; 1 for 20,000-volt, single-phase (Cartagena, Spain), and 1 for 50,000 volts (Exposition in Duesseldorf).—*Elek. Anz.*, November 8.

ELECTRO-PHYSICS AND MAGNETISM.

Demonstrating and Measuring Radioactivity.—STRUTT.—A description of a simple apparatus which exhibits in a striking manner the dissipation of negative electricity from radium by the cathode rays evolved by it, and the accumulation of a positive charge. A glass tube, *a*, with thin walls, is hermetically sealed and contains the radium preparation, as shown in Fig. 2. It is suspended from above by the quartz rod, *b*, while from its lower end hang a pair of gold or aluminum rods, *c c*. The glass tube, *a*, is smeared over with a conducting coating of phosphoric acid, and the whole system hangs from the stopper, *d*, of the glass bulb, *f*. Strips of tinfoil, *e e*, at the sides of the bulb are connected to earth. As long as there is air in the bulb no divergence of the leaves is observed, since the radium rays make this air a conductor. But if a good vacuum be made in the vessel, the leaves soon begin to diverge, owing to the loss of negative electricity by the radium. This divergence increases until the leaves touch the tin-foil strips. When this happens the leaves are discharged and collapse, and the cycle recommences. With a weak radium preparation, the author obtained a full divergence in about 20 hours. But with a more active preparation the cycle can be completed in course of a lecture. The time in which the cycle is completed is, of course, an indication of the degree of radioactivity of the substance in *a*.—From *Phil. Mag., November;* in Lond. *Elec.*, November 13.

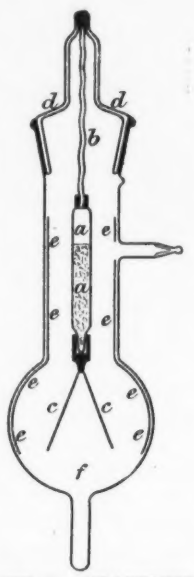


FIG. 2.—MEASURING RADIOGRAPHY.

Spontaneous Heat Emissions of Radium Salts.—Some editorial notes on a recent letter, published by Rutherford and Barnes in *Nature*. They found that the heat emission is proportional to the α radiation with which it varies directly. Only 25 per cent. of the α radiation, however, comes directly from the radium itself, while the remaining 75 per cent. is due to the radioactive emanation occluded by the salt and continuously generated by the radium. The authors, therefore, perform the following experiment: They measure the heat emission from 30 mgm. of radium bromide. Then, by heating the substance, they drive off all but a few per cent. of the occluded emanation, and condense the latter in a small glass tube cooled in liquid air. The tube is then sealed up and contains all the emanations which the radium has lost. They now find that the heat emissions from the radium has been reduced to 30 per cent., while the glass tube containing the emanation emits heat to the extent of 70 per cent. of that of the original radium. As time goes on and more emanation is produced by the radium, the heat effect from the latter increases gradually, while that from the emanation decays gradually. The actual amount of emanation obtainable from 30 mgm. of radium bromide is quite invisible and unweighable, and has so far only been detected by its radioactivity, and the phosphorescence and ionization produced by the latter. Yet 70 per cent. of the heat emission of a radium salt is due to this invisible amount of gas. This result cannot be explained on the view that the radium gains its heat from an external source, whereas the disintegration theory of Rutherford and Soddy leads directly to its prediction. On that theory the energy of radioactivity is derived from the internal energy of the atom liberated when it breaks up into smaller systems.—Lond. *Elec.*, November 6.

REFERENCES.

Permanent Magnets.—EMDE.—A communication referring to a former statement of Busch, who claimed that from all experiments made with permanent magnets the conclusion must be drawn that a permanent magnet is not to be considered as the seat of a certain number of lines of force, but as the seat of a certain magnetomotive force. The present author shows that this would lead to the result that a formula which is considered to be correct and which is very often used, must be wrong. He points out that our ideas on "true magnetism" are still vague. The question has not yet been conclusively answered, what in a "permanent magnet" is quantitatively permanent when the magnetic reluctance is changed.—*Elek. Zeit.*, November 12.

Temperature and Ionization.—MCCLUNG.—An account of an experimental investigation as to the manner in which the ionization of air by Röntgen rays is affected by the temperature. As far as his experiments go, no such effect was observed.—From *Proc. Cambr. Phil. Soc.*, October 21; Lond. *Elec.*, November 6.

ELECTRO-CHEMISTRY AND BATTERIES.

Electricity Direct from Carbon.—LORENZ.—A summary of the present state of the problem of converting chemical energy of burning carbon directly into electricity. Slow combustion involved in the electrolytic process such as in an ordinary voltaic cell suffers under three disadvantages—viz., the slowness of the reaction between carbon and oxygen at ordinary temperatures, the impurity of the carbon, which gives rise to complicated hydrocarbons in solution and the necessity of using the highly-priced conducting forms of carbon instead of ordinary coal. These circumstances lead to the adoption of a gaseous "electrode" consisting of carbon monoxide, as in the cells of Bucherer and Borchers. In these, however, the currents obtained cannot be proved to result from the further oxidation of the carbon monoxide. Indeed, the existence of carbon monoxide ions has yet to be demonstrated. Another but more indirect way of utilizing the energy of carbon is that suggested by Nernst, in which carbon is used for regenerating other cells, such as a Daniell cell, by the reduction of the zinc sulphate. Another method proposed by Nernst is to heat an accumulator having a negative temperature coefficient until its e.m.f. disappears and then let it cool. Dolezalek has, in fact, obtained an e.m.f. of 0.6 volt between two lead accumulators having a difference of temperature of 90°. The problem is theoretically soluble, but will require much detail work for its final solution.—From *Mit. Phys. Ges.*, Zurich, No. 5; in Lond. *Elec.*, October 30.

Carbon Cell.—JONE.—A long illustrated description of a cell which is called a "coal battery" for the reason that when the cell is discharged and then restored to its original condition by chemical means, nothing has been used up except coal and the oxygen of the air. The cell has a positive electrode of tin and negative electrode of carbon, with mercuric oxide as depolarizer. The latter is contained in a porous carbon cup. The electrolyte is a hot aqueous solution of caustic potash. When the cell discharges the tin electrode is oxidized to stannous oxide, while the mercuric oxide is reduced to mercury. The cell is restored to its original condition in the following way: A reduction furnace is provided for reducing the oxide of tin to metallic tin, the waste gases from this furnace being utilized for heating the cell. The mercury is converted into nitrate by treatment with nitric acid and the nitrate of mercury is then broken up by heat into mercurous oxide and nitrous vapors. By oxidizing the latter in the presence of steam and atmospheric oxygen, the nitric acid is regenerated. The e.m.f. of the cell is 1.06 volts. The efficiency of the entire cycle with apparatus of several hundred horsepower capacity, is estimated as 66 per cent. of the energy of the coal consumed. Mr. Jone has been working on this for some years.—*West. Elec.*, November 21.

REFERENCES.

Electrodeposition upon Aluminum.—FISCHER.—Some notes on depositing metallic films upon ordinary aluminum. Coatings of copper, silver, nickel, zinc and tin may be obtained directly upon aluminum,

but films of gold, "brass" and arsenic are best applied upon substrata of copper, nickel or silver. Aluminum coated with copper or silver can be "oxidized," and there will be no danger of the deposit coming off; but the use of hot liquids and more particularly the hot solutions of alkali sulphates must be avoided or the deposit may blister. If the aluminum has been tarnished by the exposure to air, it must be cleaned.—From *Chemiker-Zeitung;* Lond. *Elec. Rev.,* October 30.

Ferro Metals.—ROSSI.—An article on the ferro metals and their manufacture in the electric furnace. The reduction of the ores by means of carbon or aluminum is discussed and the properties and uses of the various ferros, and especially of ferro-titanium, are discussed in detail.—*Iron Age,* November 12.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Measuring the Wave Length of Electric Oscillations.—DOENITZ.—An illustrated description of an instrument for measuring the wave length of electric oscillations, devised especially for use in connection with tuned wireless telegraph systems. The accuracy of such measurements depends mainly upon the conditions of damping; the smaller the damping of the measuring instrument and the smaller that of the oscillating system under test, the more exact is the measurement. A circuit, containing self-inductance and capacity, is tuned to a distinct frequency, which depends in a simple way upon that self-inductance and capacity. Such a circuit with the inductance L_1 and capacity C (Fig. 3) may be charged from an induction coil, *J*.

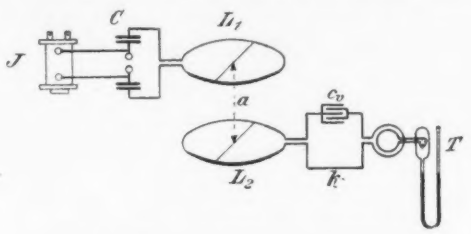
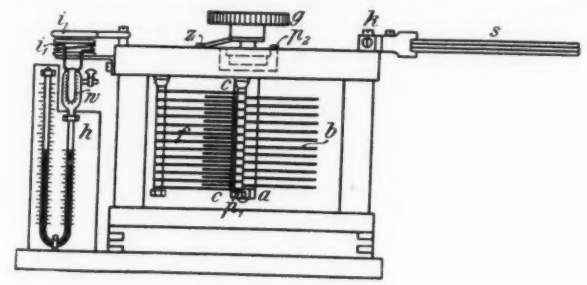
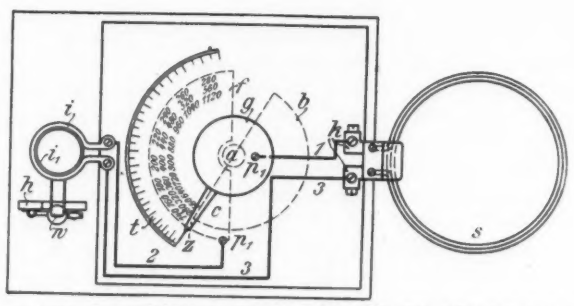


FIG. 3.—MEASURING WAVE LENGTHS.

When the condenser, *C*, discharges through an air-gap, electric oscillations of a distinct frequency are produced. A second circuit, which contains the variable capacity, *cv*, and self-inductance, L_2, is set into oscillations by the inductive action of L_1 upon L_2 and the current flowing in the second circuit is measured by a very sensitive hot-wire instrument, *T*. If the oscillation in the first circuit ($C L_1$) remains the same, the current produced in the second circuit (in which *cv* and L_2 may now also be assumed to be kept constant) depends upon the distance *a* between L_2 and L_1. If *a* is very small ("strong coupling") the resonance circuit reacts back upon the primary circuit and the resonance curve is distorted. It is, therefore, better to make *a* not too small. There is a certain distance, *a*, for which the amplitude of the current in the secondary resonance circuit (L_2) becomes a maximum. This distance, *a*, represents what the author calls a "loose coupling" between the primary and secondary circuits. If, now, this distance, *a*, is kept constant, and if the oscillations in the primary circuit are left unchanged, then in order to get resonance in the secondary circuit (which manifests itself by a maximum deviation of the hot-wire instrument, *T*), it is necessary that the product, $L_2\ cv$, has a certain value, so that if L_2 is increased, *cv* must be diminished. If the hot-wire instrument shows that the condition of resonance exists and if the values of L_2 and *cv* are known, then the wave length of the oscillation may be easily calculated. This is the principle upon which the author's instrument is based, which is shown in Figs. 4 and 5. *s* is a self-inductance and the arrangement is made that *s* may be easily replaced by coils of other values of self-induction. *c* is a condenser, the capacity of which can be changed within wide limits. *h* is the hot-wire instrument; in order to get readings of suitable value in the measurement of wave lengths of different size, this instrument is excited by the induction and the distance between the secondary windings, i_1, from the primary winding, *i*, can be changed at will. This hot-wire instrument serves only for indicating the condition of resonance, which is indicated by a maximum reading of the instrument. The capacity, *c*, is an adjustable condenser in a case filled with paraffine oil; it contains a fixed set of parallel plates, each having the area of a half circle, and all being connected to the pole, p_1. Connected to the other pole, p_2, is another set of similar plates, which can be revolved around the axle, *a*, and can thus be brought to a greater or less extent into the intermediate spaces between the plates of the other set. In this way the value of the capacity of the condenser can be widely varied. The capacity, *c*, and perhaps also the self-inductance, *s*, are changed until the hot-wire instrument indicates the condition of resonance; the wave length may then be easily calculated from the measured values of *c* and *s*. The arrangement of the instrument to make its use easy in practice is described in detail.—*Elek. Zeit.,* November 5.





FIGS. 4 AND 5.—PRINCIPLE OF INSTRUMENT FOR MEASURING WAVE LENGTHS.

Induction Coil.—ARMAGNAT.—A long article, illustrated by diagrams, on the forms of the currents in induction coils. The author discusses a number of curves obtained by means of the Blondel oscillograph with various induction coils. These curves show the usefulness of Blondel's instrument and also emphasize the incompleteness of theories on this instrument and the great complexity of the phenomena. Some conclusions, drawn by the author from his observations, are as follows: The damping of the first oscillation is due to sparks, both primary and secondary ones. Hysteresis apparently plays an important part in the damping of the later oscillations. The oscillations are not simple, at least not always, since they are the sum of various oscillations of different period and damping. The secondary current delays the demagnetization and can become troublesome for the perfect operation of the interrupter. The e.m.f's induced in both circuits depend—all other things being equal—upon the resistances opposed to the sparks, and not on the maximum value of the primary current, as long as the latter is above a certain value. —*L'Eclairage Elec.,* November 14.

Recording Mariner's Compass.—FABRY.—An illustrated description of an instrument devised by Heit, for automatically registering the course of a vessel. All deviations of the compass are automatically recorded by electromagnetic means.—*L'Ind. Elec.,* October 25.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Telephony for the Transmission of Newspaper Reports.—A note stating that the use of the telephone—instead of the telegraph—is now being introduced commercially for the transmission of newspaper reports. A recent two hours' speech of Chamberlain at Birmingham was thus transmitted to London and while the speech was concluded at 10:05 P.M. an edition with a verbatim report of the speech was issued in London at 10:32.—Lond. *Elec.,* November 6.

Wireless Telegraphy.—The first part of an article giving brief abstracts, often illustrated by diagrams, of patents granted since 1901, in various countries on the subject of wireless telegraphy.—Lond. *Elec.,* November 6.

MISCELLANEOUS.

Radium and Cancer.—A note on a recent report of Exner on the treatment of cancer by radium. In nine cases under observation radium has effected very considerable abatement in the cancerous swelling, and in two of these cases the swelling has not reappeared, although five months have elapsed since the treatment. In one case,

where it was impossible to operate for cancer in the palate, radium had effected considerable improvement, the swelling having been reduced to a minimum. Exner concludes that in cases in which an operation is possible this course is preferable; but the radium treatment is advisable in cases where an operation is impossible.—Lond. *Elec.*, November 6.

British Electrical Engineering Statistics.—DIGBY.—The first part of a statistical article on the import and export trade of the United Kingdom so far as "electrical goods" are concerned. Several tables and diagrams are given showing the variation of the export trade from the United Kingdom during the last 10 years. The general tendency of the article seems to be to show that opinion held by many Englishmen—that England has lost her proper position in the manufacture and supply of electrical machinery—is too pessimistic. In an editorial note it is said that the Board of Trade returns, upon which the tables are based for the most part, cannot always be relied upon for proper classification, and that the figures given for imports of electrical goods are undoubtedly too low. The article is to be continued.—Lond. *Elec.*, November 6.

New Books.

ATLANTE DI MACCHINE E CALDAIE. By Salvatore Dinaro. Milan: Ulrico Hoepli. 80 pages, 112 illustrations. Price, 3 lire.

This little volume is somewhat unique, both as a specimen of bookmaking and of editorial work. The first 110 pages consist of a similar number of full-page diagrams, reproduced from dimension drawings and are evidently accurately to scale. The plates treat exclusively of steam apparatus, showing sections of various kinds of boilers, furnaces, boiler settings, methods employed in boiler construction, steam gauges, valves of all kinds, blowers, steam pumps, indicators, steam whistles and finally assembled steam engines. Then follow 80 pages of concise descriptions of the various plates which are so compressed as to be definitions rather than descriptions, and would be readily comprehended only by those who are skilled in the art. As a handbook for the draughtsman occupied in designing steam machinery the book will be found an exceedingly desirable companion.

DIE MONTAGE ELEKTRISCHER LICHT UND KRAFTANLAGEN. By H. Pohl. Hannover: Gebruder Janecke. 272 pages, 328 illustrations. Price, 4.40 marks.

This is a handbook for the power station designer and operator, chiefly directed to illustrating the methods of installing electrical apparatus in electric light and power stations. There is little discussion of the merits of various kinds of apparatus, for the intention of the book is to show how to install and not what to install. It is very completely illustrated with half-tones, from a number of the largest German stations, together with reproductions of the floor plans and switchboard drawings from which these plants were constructed.

The data upon switchboards, together with plans and instructions for wiring between generators and other station apparatus is particularly worthy of attention. Full illustrations are given of the methods used in bringing circuits into the building and the precautions which should be taken in installing the conductors.

In style the book is chiefly descriptive, although there is considerable valuable tabular matter of a statistical nature. It is not a book for the beginner, but for the practicing electrician.

TELEPHONY. PART IV. CONSTRUCTION OF AERIAL LINES. By A. V. Abbott. New York: McGraw Publishing Company. 277 pages, 143 illustrations. Price, $1.50.

This interesting and valuable book constitutes Part IV of the series which Mr. Abbott has been contributing to the pages of ELECTRICAL WORLD AND ENGINEER, and which are now being reduced to book form. There will be six parts in the book series, and the present section deals specifically with pole lines. It might seem that this subject was more or less hackneyed, but Mr. Abbott has brought to bear upon the theme a vast amount of special information, and has illustrated his book with a large number of new cuts and diagrams. The various topics treated include the poles as such, discussion as to timber used, questions relating to iron and copper wires, estimates and costs of the work, cross arms and pins, guy wires, etc., comparisons between the costs of overhead and underground work, and other details of a like nature, in regard to which the book may be said to embody all the latest and best practice. Telephonic work represents the two extremes of pole line construction in goodness and badness, and Mr. Abbott's book sets a standard not only as to what may be avoided, but as to what should be copied and insisted upon. It is encouraging to believe that in telephonic work the lighter and flimsy construction of earlier years is rapidly disappearing, so that at no distant date telephone aerial circuits as a whole will compare favorably with those employed in any other class of electrical transmission. The book is well printed and has a complete table of contents and list of illustrations, as well as an excellent index. The parts now printed in this series include the location of central offices or exchanges, underground conduits, the cable plant, and the present section on aerial lines. The parts that are to follow will deal with the sub-station or subscriber's apparatus and switchboards, and central office apparatus. When complete the series will present an encyclopedic review of the practical telephonic art of the day.

Fire-Proof Wire with Homogenous Insulation.

BY WILLIAM H. EASTON, PH.D.

The most important function that is required of an electrical insulator is that it shall insulate. In view of the vast number of materials that offer sufficient resistance to the electrical current to be used as insulators and in view of the universal use for which such substances have been employed, it may seem a little absurd to say that the present insulators are not fulfilling their primal duty under such conditions to which they are constantly subjected. All varieties of conditions have appeared to which insulators must conform and in the majority of cases the demands have been met to entire satisfaction. From the Pacific cable to the finest wire used in the most delicate instrument, the whole ground seems to have been covered—water, frost, pressure have been guarded against with entire success—the heaviest known currents have been confined within conductors without damage to the dielectric—indeed, almost every adverse force has been successfully combated with except one, and that is heat. While admirable in all other respects, the insulations used generally to-day are singularly defective in offering any resistance to a temperature much above the boiling point of water, and in consequence there is scarcely a mechanism of whatever kind in which the electric current is used that does not have to be guarded with the greatest care lest a sudden overheating should destroy the insulation upon the wire and render the apparatus useless. Considering the commonest materials that are used for insulating wires—cotton, silk, rubber, paraffin, etc.—it is seen at once that all are of an extremely inflammable nature, and more than this, are rendered unfit for use at temperatures far below the point where they would burst into flame.

It is to fill this gap that the Heany fire-proof wire has been devised and manufactured. No one with the least experience in electrical matters can fail to see the great importance of a wire that heating cannot injure. Defective insulation is said to be the greatest stumbling block to electrical progress, every failure of the insulation being another argument for the use of a steam or gasoline engine that has no such delicate material within its makeup. Cotton is the chief among insulators for many reasons, but cotton must contain 15 per cent. of water to be flexible and strong. When dried out it is brittle and can be crumbled. Now, there is nothing easier than for a conductor carrying a current to become heated. In dynamos and motors, where perfect insulation is absolutely essential, and where in many ways the highest type of electrical development and use is found, such heating is an invariable consequence of their use. The flow of a current through a conductor, as all offer resistance, always produces heat—unnoticeable in some cases, but intense enough to melt the most unfusible conductors in others. Motors and dynamos in use always become heated to a slight degree, and this has the effect of drying out the cotton, rendering it brittle as mentioned above. Now, even with the most careful use, cotton in this condition will not support forever the pressure it must bear within a coil, and it becomes crushed, a short-circuit is developed and in a second the whole coil burns out. But how frequently does a more serious accident bring

such a machine to an abrupt end? Loss of time and money are only the lesser evils of this occurrence—the worst being the loss of prestige of electrical machines in general. What is true for motors and dynamos is true for all electrical devices. Measuring instruments, arc lamps, telephones, telegraphs, etc., all have to undergo the same risk of being destroyed, no matter how well protected, for nothing is "fool-proof," and no one can say where the lightning will strike next. There is also another and a more serious aspect of the case. While such insulators are easily destroyed they are also among the chief of destroyers by fire.

These are the main considerations that have called the Heany fire-proof wire into existence, and though to withstand heat is the main purpose in its manufacture, none of the other properties of insulation must be neglected. The covering employed must be strong, flexible and moisture-proof, as well as offering a high resistance to the current. To do this requires a total departure from the usual methods of insulating wire. The Heany insulation consists of a fibrous web so cemented together and so treated by heat and pressure that it not only forms a compact, homogeneous mass in itself, but forms a chemical union with the copper wire, and this union is strengthened by heating, no matter to what degree. The accompanying cut shows the method by which this insulation is applied. A^2 is the copper wire, a^1 a chemical adhesive upon which the fibre is placed in a flocculent form, A^1 gives the completed wire after being firmly compressed and the constituents united by heat. All this is done in one operation and it may be mentioned that this insulation is not more costly than a double nap of cotton and less in thickness, and the diameter shows a deviation of not more than 0.002 of an inch when measured by a micrometer.

SECTIONS OF FIRE-PROOF WIRE INSULATION.

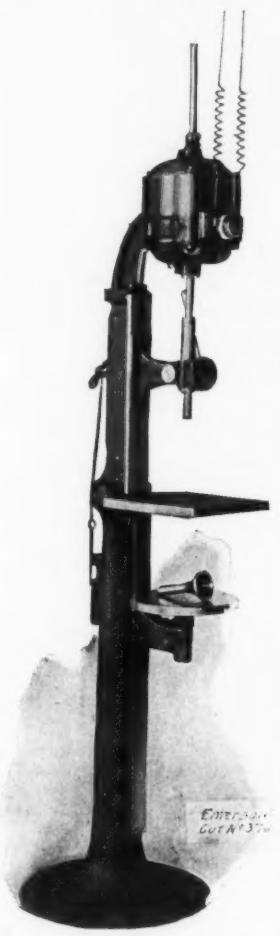
This insulation is practically indestructible. It is very strong and perfectly flexible, withstanding bending and twisting that will break the wire before it parts, without cracking, dripping or peeling off. Weathering for months does not injure it, nor can heat, cold, water or acid cause it to lose its flexibility and strength. It cannot be crushed on the wire by winding in coils and resists abrasion admirably. Its most important property is its ability to withstand heating without injury. As it contains nothing that is inflammable, it cannot burn or carry flame, and it will resist temperatures that will cause the copper within to melt before breaking down. A coil in Mr. Heany's laboratory at York, Pa., has been heated red-hot once a day for several months by a heavy alternating current and still remains perfect, while long before red heat is reached the coil becomes hot enough to set fire to wood, paper, etc., showing that a temperature sufficient to set fire to the building containing the motor used does not harm the insulation in the least. In the official test, the wire was made red hot for thirty minutes with 45 amp. and then finally the conductor fused, but before this there was no break-down. This means that no accidental overload can in any way injure the insulation on the wire in coils and the immense value of this property must be evident to every one who has had any experience in electrical devices.

Another great advantage lies in the fact that a minimum sized wire may be used in all electrical apparatus—such as motors, generators, solenoid and magnet, etc.—the fusing of the wire and the protection of the building alone being considered in calculation of the factor of safety. For example, let us say No. 16 wire will carry the current and do the work well, but yet for the safety of the cotton insulation No. 14 wire must be used, as a smaller conductor will heat much more readily than a larger one in case of accident. With the use of the present insulation, however, smaller wire may be employed, saving 30 per cent. or more of the weight of metal and reducing the machines and instruments to one-third in size. Here we have a great saving in first cost, and the absolute assurance that burning out is impossible, and that since mechanical accidents to a motor are of rare occurrence compared to the frequency of damage to the insulation, the machine will, speaking generally, have to wear itself out before it ceases action, and is transformed from a rather doubtful to an exceedingly reliable piece of mechanism. The insulation is also moisture-proof; that is, short of running the machine under water, no harm can come to a motor from dampness, no matter of what degree, and it may also be said here that the ohmage resistance of this insulation has proven to be higher than that of ordinary cotton-covered wire.

For line wire, etc., where an absolutely water-proof wire is demanded, the wire described above is taken to another machine, where it is run through a bath that covers it with a material that renders it perfectly water-proof, and this in turn is protected by a braid. The composition used for water-proofing is peculiar in that it is entirely fire-proof, and as it is perfectly flexible, the excellent qualities of the magnet wire are in no way deteriorated and a perfect wire is obtained. The line resists abrasion very strongly and is perfectly incapable of burning or carrying flame. Wire of any size may be covered, the machines are simple, easily built and can be superintended by a boy or girl, and are capable of turning out 400 pounds of No. 14 B. & S. gauge wire per day per machine.

Slate Drill Press.

An interesting illustration of the advantages of electric drive is found in the Emerson slate drill press herewith illustrated. This outfit consists of the slate sensitive drill press in combination with an Emerson direct-current motor, which has a special compound winding of a standard ¼-hp enclosed frame, and while requiring no more current than a 32-cp lamp when running free or with small drills, it has ample power for work within the range of this tool. It is robustly constructed, well protected from dirt and chips, and will stand ordinary rough usage without requiring attention or repairs. Owing to the specially-compounded shunt and series field, this motor is connected direct from line to binding posts without starting box, being started and stopped from a small two-pole snap switch within convenient reach of the operator. The rush of starting current is cared for by the speed-regulating coils of the motor itself, and the proportions of this field are such that if the motor should be stopped entirely by a drill sticking in the work, or by the use of too large a drill, no damage to the motor would result. This special winding also enables the motor to automatically adjust its speed to the size of the drill in the chuck and the material being drilled. Speed regulation is obtained by the motor itself and is entirely automatic. A motor with a higher initial speed is furnished for use where a large proportion of the work is to be with small drills, but the regular motor is best adapted to general tool room use; and the range of speeds above given covers a wide variation in size of drills and in material. This motor will handle work up to the full capacity of the drill press, and in fact will drill in cast iron with a ⅝-in. drill, although not recommended for such heavy use.



SLATE DRILL PRESS.

The simplicity and automatic features of this combination, admirably adapt it to general shop use, and its convenience and accuracy make it invaluable for tool room and fine experimental work. It may be placed and operated in any place where 110 or 220-volt direct current is available, but it is not recommended for 500-volt circuits, as this pressure is too high for such a small motor, and the operator might be in some danger from possible grounds in the circuit. The apparatus is built by the Emerson Electric Manufacturing Company, of St. Louis.

New Motor-Car Equipment of the Central London Railway.

For some eighteen months or more two experimental trains, each consisting of two motor cars and four trailer cars, equipped with the multiple-unit control system, have been on trial on the Central London Railway. With the exception of a modification at one end to suit a truck carrying two 75-hp motors, the motor cars are practically identical with the ordinary cars.

Briefly, there are only two methods—omitting the single car acting independently—of operating heavy electric passenger traffic, namely, (1) the locomotive system and (2) the multiple-unit system. The former follows steam precedents and possesses practically the same limitations, while the latter is a method of train operation and control by means of which cars are equipped with motors and motor controllers individual to each car. The advantage of this system is that any number of these cars may be connected to any number of cars similarly equipped, or with any number of cars which have no motors, to form a train of any length and operated from as many points as desired, through a controlling line common to all cars. In other words, every motor car is a unit, and any combination of motor cars and trailer cars may also be considered a unit which can be operated from either end and joined with other units.

By this method of train operation locomotive shunting operations are abolished, trains can be reversed at any cross-over and traffic concentrated on any part of the road. An important feature of this system, also, is the complete absence of vibration and strain where tunnels and elevated structures are concerned. The directors of the Central London Railway, finding that with these multiple-unit trains vibration was entirely eliminated, and that by their adoption they could lengthen the trains considerably, decided to use them for the complete working of the line.

The new trains are made up of five ordinary and two motor cars. The motor trucks, which are of the equalizer type, carry two British Thomson-Houston 125-hp motors. The motors are of the solid-frame type, the field magnet being a single casting supported by two bearings on the truck axle and a lug resting on a bracket, which is riveted to the transom.

To facilitate access to the armature the magnet frame is provided with openings at each end. These openings are closed by circular castings. The armature has ventilating ducts, 39 slots, with 10 conductors per slot, and is series-wound.

Each motor weighs 4,375 pounds, including gear, 2,040 pounds of which are borne by springs, and with 200 amp. at 500 volts each gives a tractive effort of 3,150 pounds at a speed of 14½ miles an hour, measured at the tread of the wheel (which is of 34 in. diameter). The temperature rise after a day's service of 16 hours is about 30° C. above atmosphere.

The collector shoe is of chilled iron suspended from the truck by four links. The truck supporting the passenger end of the carriage is, to all intents and purposes, the same as that of the trailer carriage, save that it has a wider wheel and carries a collector shoe like that on the motor truck.

The master controllers, contactors, reversing switches, resistances and the various other apparatus on the Central London trains, are carried on the driving platforms of the motor cars. The contactors are carried on an angle steel frame inside the cab, and below them are located the reversing switch and rheostats.

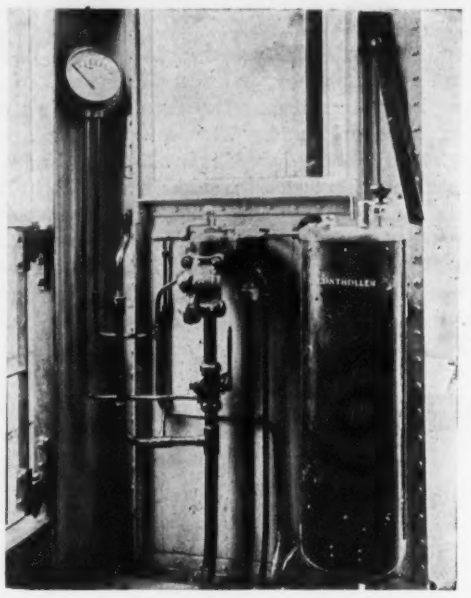


FIG. 2.—CONTROLLER AND BRAKE MECHANISM.

A slate panel behind the driver carries switches and fuses for the main motor circuit, control circuit, lighting and air compressor circuit. The motor circuit connections on the switchboard are of bare copper rod, while those of the control circuit are of asbestos-covered wire.

The air compressor, main reservoir, tool chest and sand boxes are situated on the opposite side of the cab to the switchboard. A series motor directly drives the compressor, which compresses 20 cu. ft. of free air per minute, and is provided with an automatic governor, which cuts off the current when the reservoir pressure

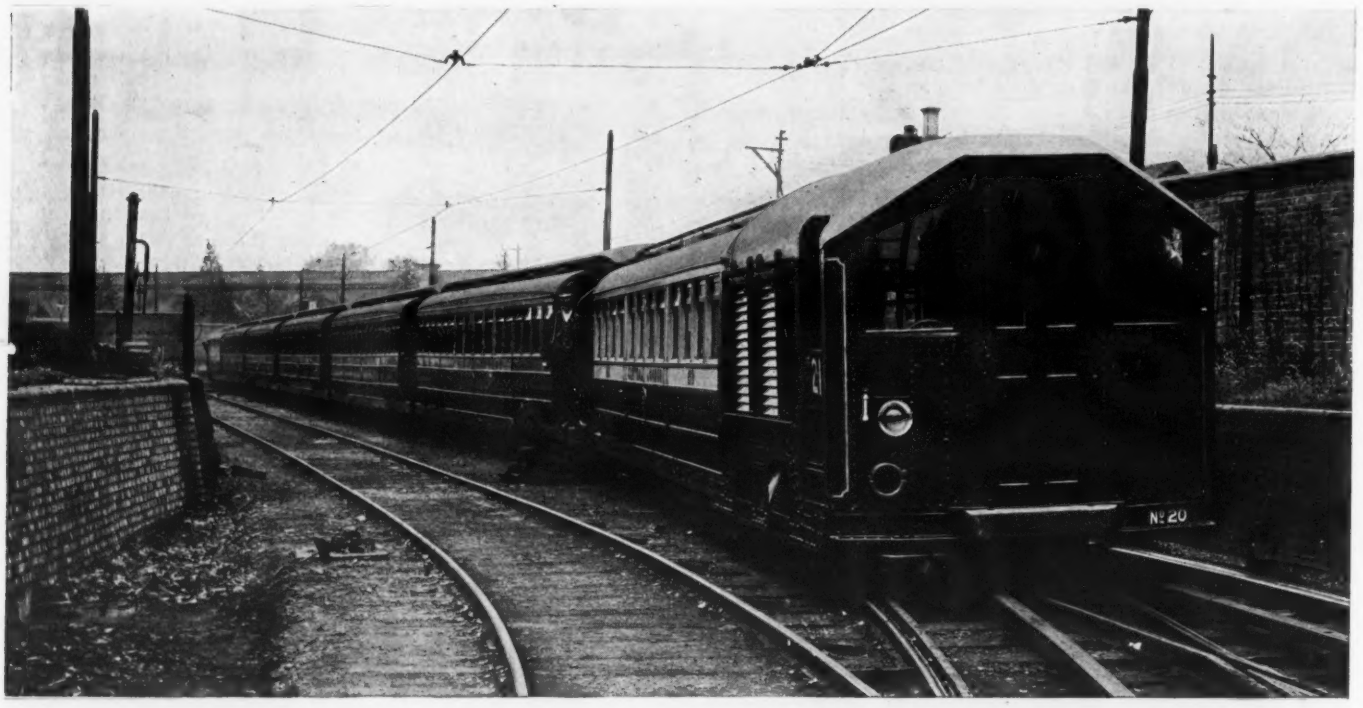


FIG. 1.—FIRE-PROOF ELECTRIC TRAIN ON CENTRAL LONDON RAILWAY.

reaches 90 pounds per sq. in., and switches it on when the pressure falls to 80 pounds.

The master controller, as mentioned above, is situated on the driving platform, together with the apparatus for operating the air brake, as are also the ammeter, voltmeter, air pressure guage and hand brake wheels.

Each motor car with the full complement of passengers weighs 23 tons, 16½ tons of which are supported by the motor truck and 6½ tons by the truck at the passenger end of the car. The trailer cars have a seating capacity for 48 passengers, the motor cars for 42.

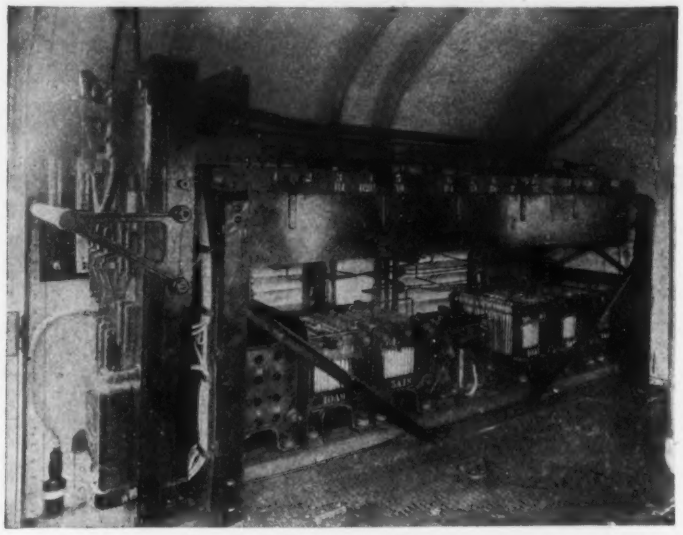


FIG. 3.—CONTROLLING MECHANISM ON PLATFORM.

The underframe of the motor car is bent over the top of the motors and carries a car body similar to those on the trailer cars, but somewhat shorter. The cab is constructed entirely of steel, the floor being of checker plates, which are hinged in order to give access to the motors. Every precaution has been observed to obviate fire hazard.

The weight of one of these seven-car multiple-unit trains is 132.5 tons, while a seven-car train with gearless locomotive weighs 159.6 tons. The operation of trains by the multiple-unit system is of the simplest character, and the officials of the company describe it as being perfect in every respect.

Modern Types of English Alternators.

Although a great deal of pioneer work in the alternating-current field has been done in England, and of a very creditable character, it is the fact that of late years during the period of development of electric light and traction systems by means of polyphase current, English managers and consulting engineers have felt compelled to order abroad a very large proportion of the necessary alternating-current machinery. To remedy this situation, Dick, Kerr & Company, whose direct-current generators and motors are already so well known, have recently devoted considerable attention to the newer class of apparatus and have lately been producing at their Preston works, alternators of the largest size, not merely for England but for the world at large.

Though starting comparatively late in the manufacture of polyphase machinery, English shops have not been entire losers for, by a process of selection, they have been able to avoid many features of design which did not specially commend themselves. In other words, it has been possible, by utilizing the experience of foreign manufacturers, to adapt and adopt designs which are more suitable for local conditions. Among the orders for polyphase plants which Dick, Kerr & Co. are completing, may be mentioned the following:

London County Council, two 1,500 kw (alternating), twelve motor generators, each of 300 kw and three motor generators, each of 50 kw. Horndean Tramways, two motor generators, each of 200 kw. Portsmouth Corporation, two motor generators, each of 200 kw. Sydney, one alternator, 300 kw; two alternators, 600 kw; six motor alternators, 300 kw. Stalybridge, three alternators, each of 500 kw. Malvern, two alternators, each of 100 kw. Fulham, one alternator, 600 kw. Osaka, one alternator, 210 kw. Durban, one alternator, 500 kw. Lakefield Portland Cement Co., Ontario, Canada, one alternator of 1,000 kw; one alternator of 450 kw. Shawinigan Water & Power Co., Montreal, Canada, one alternator of 3,750 kw. Metropolitan Electric Supply Corporation, eight motor alternators, each of 500 kw. And amongst other orders may be mentioned complete plant comprising generators and sub-station machinery for the electric equipment of the Liverpool & Southport division of the Lancashire & Yorkshire Railway, Leeds & Wakefield Light Railway, Tokio Electric Tramways.

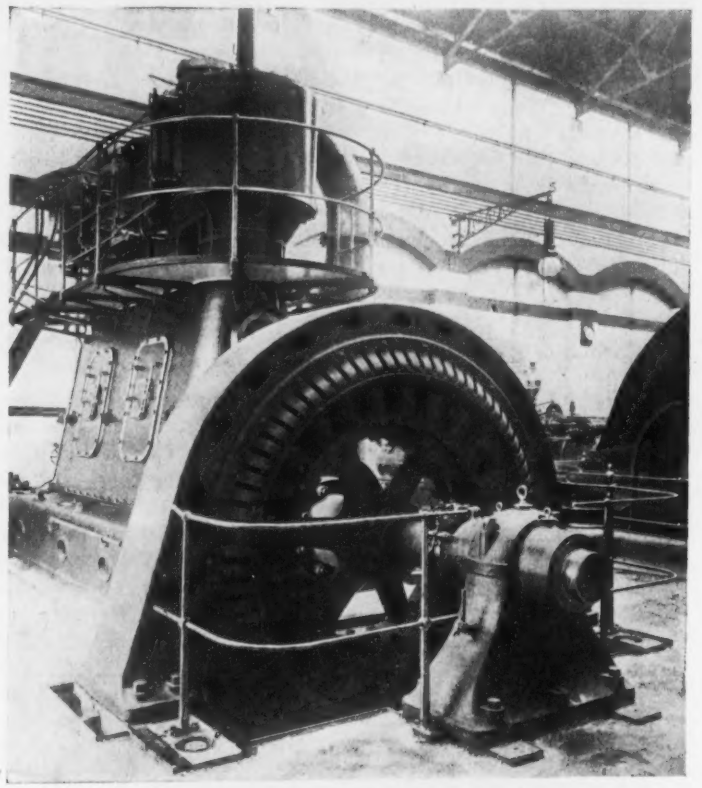


FIG. 1.—ALTERNATOR FOR FULHAM ELECTRICITY WORKS.

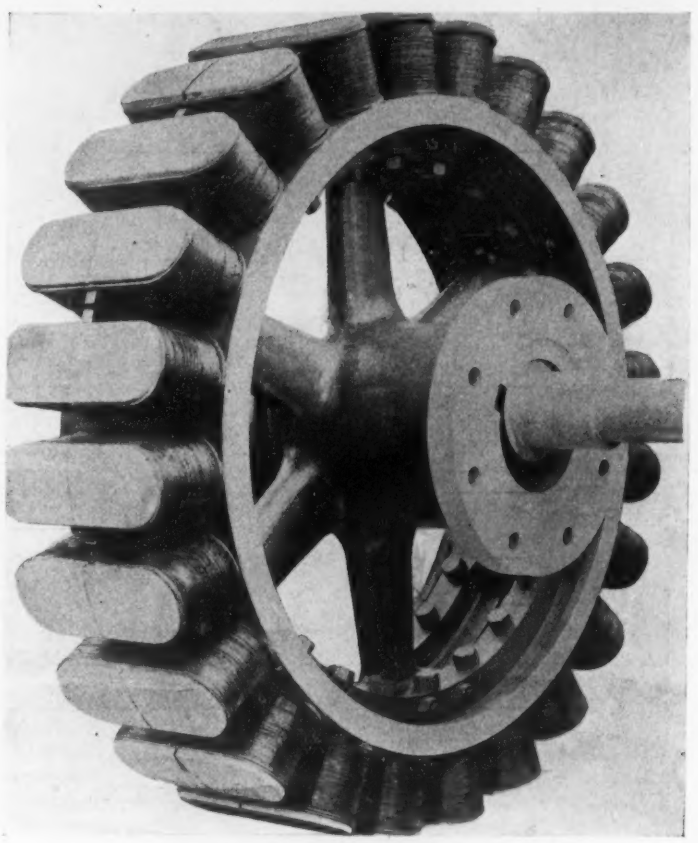


FIG. 2.—ROTOR FOR FULHAM ALTERNATOR.

In the design of polyphase alternators, necessarily some regard must be paid to the purpose for which they are to be used, and though the variations essential to meet such conditions are only of a minor character, they affect to a considerable extent the performance of the machines under working conditions. It is the adequate meeting of such conditions which determines the success of a design. In general, however, the following description covers the main features of the Preston alternator. The rotor spider is made of cast-iron, and of strong design, the hub being provided with a flange for bolting to engine flywheel. It is invariably pressed on to the shaft by hydraulic pressure, and then key seated. On the spider rim, dove-tailed laminations are fixed by means of machined bolts and cast-iron flanges, the pole pieces being then bolted on. The laminations are built up in such a way that ample spaces are provided at defined positions, the number and size of ventilating spaces being dependent on the width of the stator. The pole pieces are made of laminated steel, held together between two cast steel end plates of strong construction. The upper part is T shape, in order to securely hold the field coils in position. The lower part of the pole piece is dove-tailed for fixing on the rim of the rotor, it being then held in position by means of keys. The removal of field coils is effected by sliding the pole piece from the dove-tailed groove parallel to the shaft without disturbing any other part of the machine, such an arrangement being of extreme convenience not only when it is necessary to remove a field coil, but also for the removal of a stator coil. It should be added that the design and shape of the pole pieces gives a distribution of lines of forces in the air gap to produce an approximately sinusoidal shaped wave of e.m.f.

In the winding of the field coils it is obviously a mechanical advantage to use edge-wound strip and whenever the excitation voltage permits, the field coils are wound with a single layer of copper strip wound edgewise, and insulated between the turns by means of specially prepared fibrous material. The external surface of the

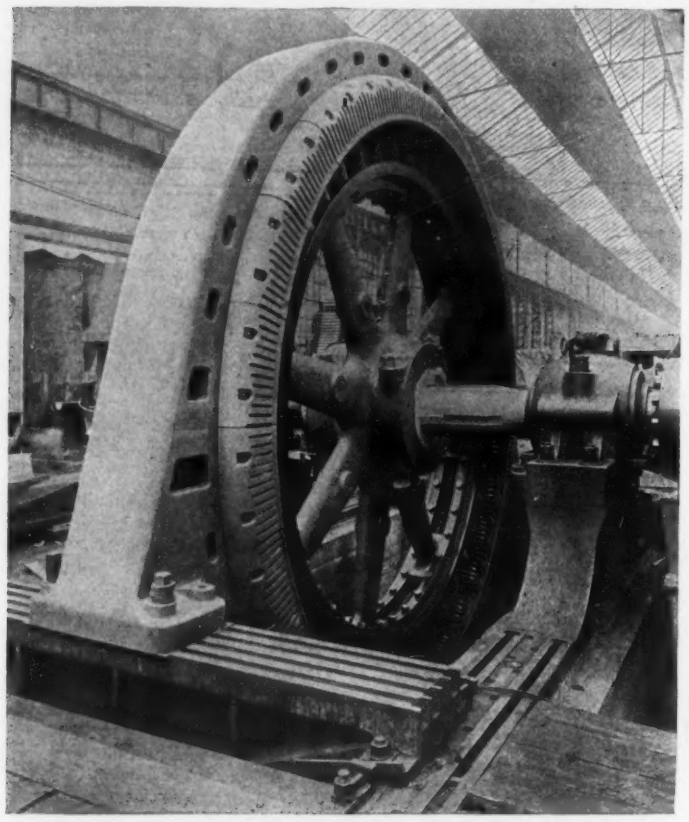


FIG. 3.—1,500-KW GENERATOR FOR YORKSHIRE & LANCASHIRE RAILWAY.

windings is left practically bare, being protected merely by insulating varnish which allows a rapid radiation of heat.

The stator frame, even in the largest type, is built in two halves, which are securely bolted together by means of finished bolts. The lower half of the frame is provided with feet which rest upon the foundation bedplate. In the larger size machines the lower part of the underframe is provided with a special screw for vertical and horizontal centering of the stator relative to the rotating field. The frame is made of high-grade cast-iron, and is designed to allow complete ventilation of the laminations, and at the same time to secure rigidity of the frame.

The core is made up of thoroughly annealed soft iron laminations, the individual laminations being well insulated from each other, to minimize eddy current losses. The laminations are held in position

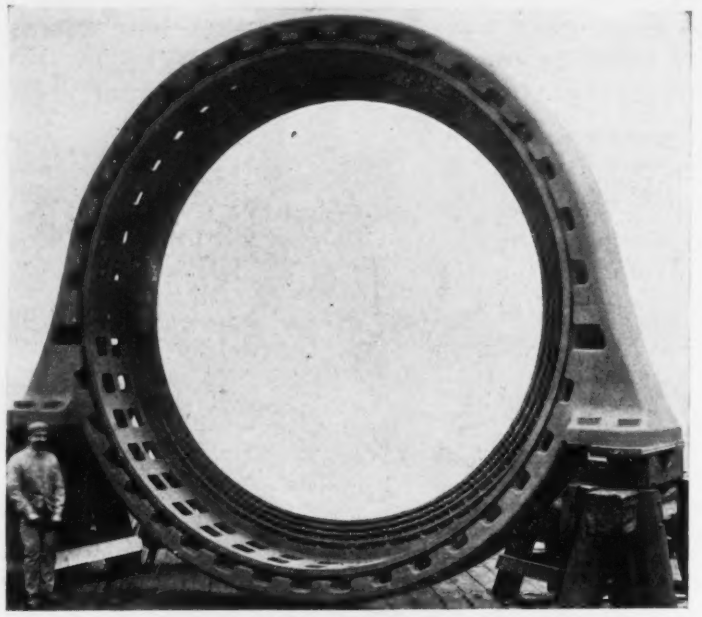


FIG. 4.—ALTERNATOR FOR LONDON COUNTY COUNCIL.

in the frame by means of retaining machined bolts. The winding is formed of separate coils, thoroughly insulated, having great rigidity, and a well-defined mechanical shape. The coils are former wound, and embedded in rectangular slots, and held in position by wooden wedges, and can be easily and quickly replaced. A lower half of a machine is shown in Photo 161, while Photo 162 shows the assembled coils in position.

The connections between the stator coils are made by means of highly insulated cables, and are easy to trace and locate. The coils are protected outside the laminations by means of a cast-iron shield, cast in sections, bolted to the frame and easily removable. This

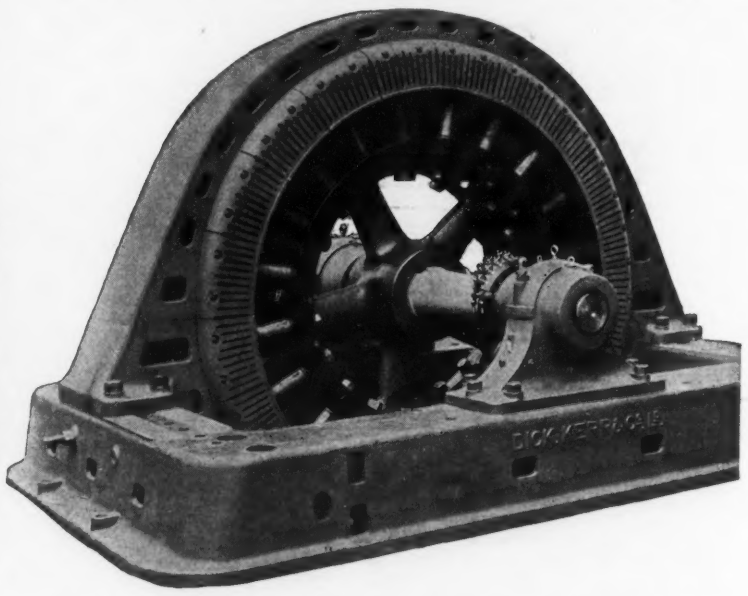


FIG. 5.—4,000-KW ALTERNATOR FOR SHAWINIGAN FALLS POWER CO.

shield is of a perforated design, and does not interfere with the ventilation of the stator winding.

The collector is composed of rings of suitable metal, fixed to the shaft next to the rotor by means of a spider and insulated pins, ample provision being made for free air circulation round the same. The brushes are made of carbon, of ample surface, are in duplicate, and can be set and replaced while the machine is running. The brush-holders are so constructed that the current will not pass through moving joints or tension springs, and will allow for tension

adjustment. The support is made of cast-iron, of light design, fixed in an advantageous position.

One of the machines here shown is a 1,500-kw, 3-phase alternator, which is part of the plant for the electrification of that portion of the Lancashire & Yorkshire Railway between Liverpool and Southport. It is to be coupled to a horizontal engine by Yates & Thom, of Blackburn, and gives its full output at a voltage of 6,500, and a periodicity of 25. Another is a 2-phase generator of a capacity of 3,750 kw, which has been constructed for the Shawinigan Falls Power Company, Canada. It is to be coupled to an Escher Wyss

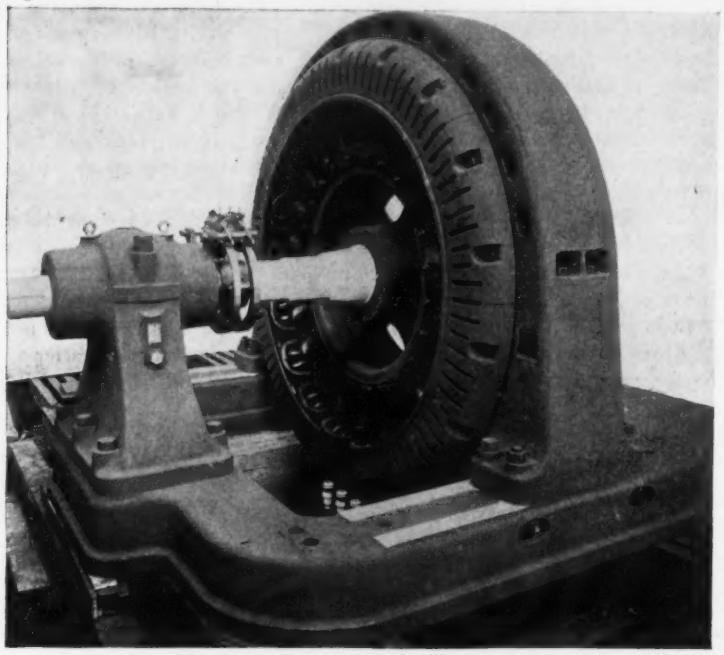


FIG. 6.—ALTERNATOR FOR LAKEFIELD, CANADA.

turbine, running at 180 revs., the periodicity being 30 and the voltage 2,200. Quite a number of machines have been built at Preston for export to Canada, and it is worthy of record that English manufacturers should be now in the position of being able to export polyphase machinery to the colonies, to Australia, Japan, South Africa, India and other places abroad, as indicated by the above list and by some of the accompanying cuts.

It remains to be added, that the alternators have been constructed to the designs of Mr. A. P. Zani, who possessing experience in alternator design gained both in the United States and on the Continent, has been enabled to develop his ideas in the direction of sound mechanical design and efficiency of performance.

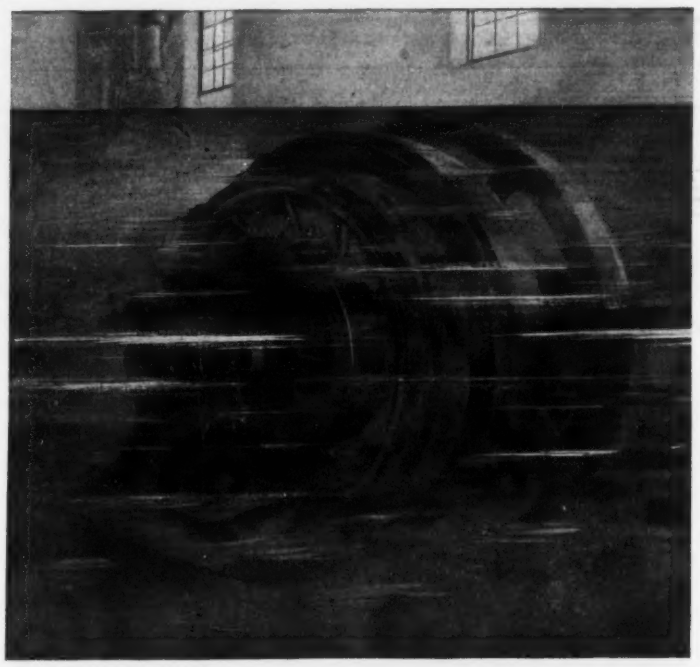
Rehabilitation of a Flooded Power Plant at Kansas City.

Although it was completely submerged for several days during the memorable flood, this year the mechanical plant of the Cudahy Packing Company, at Kansas City, Mo., is running as perfectly as ever with absolutely no indications of the damp experiences it has so recently passed through. The engines and boilers were naturally well adapted to withstand the effects of a soaking, and after the accumulations of mud and rust had been removed they were easily restored to running conditions. The generators, on the other hand, by construction less protected, required a somewhat more rigorous treatment before they were in shape to operate. That they were saved at all reflects great credit to the means employed and the sound construction and efficient insulation of the machines.

The plant is a comparatively modern one, having been installed but a little over three years ago. The engine room accommodates two large steam-driven ammonia compressors, used in connection with the refrigerating system, and two direct-connected engine-generator units each consisting of a Buckeye horizontal engine and a Crocker-Wheeler direct-current generator. The set shown in the accompanying illustration has a capacity of 350 kw, and the other, not shown, is similar but smaller, having a capacity of 200 kw. The information regarding the flood and the manner in which its after effects were removed, is given by the chief electrician of the plant, Mr. C. O. Fitch.

Mr. Fitch states that, starting on a level with the lower fields on May 31st, the water rose very rapidly until it reached a height of about 12½ ft., indicated on the photograph by the heavy line along the walls. It remained at this level for forty-eight hours, and then fell very gradually, taking ten days to reach the floor line. As the water subsided the engineer and his assistants made their way about the engine room on a raft, and with a force pump kept the mud washed off from the exposed parts of the machinery. Finally, when it became possible to stand on the bottom with high rubber boots on, the mud, which was about 2½ ft: deep on the floor, was removed from around the engines and generators, and the washing process continued down with the descending water level until the latter was well below the floor and the lowest parts of the machines. When the water and mud were out of the way, housings of double thickness matched flooring were built over the generators, and steam coils were placed under them along the bottom at each side. They were then left for a week with live steam turned on day and night, after which, while still enclosed, the generators were slowly revolved for a time. The housings were then torn down, the generators thoroughly cleaned and the brush yokes and studs taken apart and brightened up, especially at all points of electrical contact. For the first trial the machines were brought up to full voltage very gradually, and the load applied by degrees as different parts of the plant were started up. From the outset no difficulties of any sort were experienced, and the machines have been running satisfactorily ever since.

Besides the generators there were twenty-two motors, ranging in sizes from 1½ to 75 hp, which were in the water for about the same period. These were either taken apart and carried to the engine room to be baked out in one of the housings there, or in the case of the larger sizes (two of 50 hp and one of 75) were housed where



SUBMERGED GENERATOR.

they stood and treated in the same manner as the generators. These also are all running at the present time and doing their regular work, apparently none the worse for their drenching. Probably the most remarkable feature of all is that neither the generators nor motors have suffered even so much as an increase in their maximum heating temperatures, or a loss of efficiency.

Fire at Bullock Works.

The Bullock Electric Manufacturing Co., Norwood, O., had a fire on Nov. 28 in its No. 2 shop, containing punch presses, annealing ovens, forges, etc. The plant there was partially destroyed, but the tools were not seriously injured. The company has already erected temporary sheds over the tools, and there will be no delay in filling orders on hand, or that may be received. Shop No. 2 is being rebuilt forthwith on a larger scale. The loss is fully insured.

American Metal and Machinery Exports.

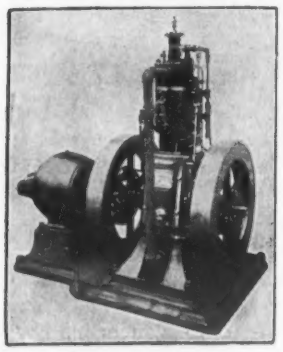
Machinery forms by far the most important feature in the exports of American iron and steel manufactures. The various classes of machinery which can be separately stated, are locomotive engines, stationary engines, fire engines, electrical machinery, sewing machines, typewriters, shoe machinery, cash registers, laundry machinery, printing presses, and pumping machinery. Aside from these, however, is a great group of machinery which is not stated in separate items in the export returns, owing to its variety and the large number of different classes of machinery included. This single group of "machinery not separately classified" grew from ten million dollars in 1892 to over twenty millions in 1902. The next largest item under the general classification of machinery is electrical machinery, which was only separately classified in 1898, amounting in that year to two million dollars, and in 1902 to nearly five and a half millions. Sewing machines, which amounted to two and a quarter millions in 1889, were over four millions in 1902. Typewriters, which were only separately stated in 1897, amounted in that year to less than one and a half million dollars, and in 1902 to nearly three and a half millions.

Locomotives increased from one and three-fourths millions in 1892 to five and a half millions in 1900; but owing to the great demand of the home market upon the manufacturers of the United States, fell to three and one-fourth millions in 1902. Metal-working machinery, which was not separately stated prior to 1898, grew from four and one-half millions in that year to over seven million dollars in 1900; pumps and pumping machinery is next in order in the class (machinery), a little over two million dollars; cash registers grew from $813,000 in 1900, the first year in which they were separately stated, to $1,144,062 in 1902, the other classes of machinery ranging downward in their relative order of magnitude, shoe machinery, printing presses, stationary engines, laundry machinery and fire engines.

Thus machinery alone formed in 1900 fifty-five million dollars' worth of the exports of iron and steel manufactures out of a grand total of $121,913,548 of iron and steel manufactures exported in that year, or nearly one-half of the total. This statement of "machinery" does not include agricultural implements, bicycles, telegraph and telephone instruments, or other articles not exclusively or chiefly of iron and steel. Adding only those items of machinery included under iron and steel manufactures, it may be said that the exportations from the United States of machinery as a group amounts to about $75,000,000 annually. Next in order after machinery is the group locks, hinges, and other builders' hardware, amounting to six million dollars; wire, over five millions; pipes and fittings, five millions; steel rails, nearly five millions; tools, three and one-half millions; structural iron and steel, three millions; boilers and parts of engines, nearly two millions; castings, one and one-half millions; and other articles ranging downward in their relative value, wire nails, firearms, pig iron, steel bars, stoves and ranges, bar iron, steel sheets and plates, wire rods, saws, cut nails, iron sheets and plates, tacks, scrap iron, cutlery, safes, car wheels, tin plates; hoop, band and scroll iron billets, ingots and blooms, and iron rails.

Single Cylinder Gas Engines for Dynamo Operation.

The use of a gas or gasoline engine that will give regulation sufficiently close for connection with a dynamo is a point that has been considered for many years. A machine which has recently been put on the market of the single-cylinder type is, it is asserted, unsurpassed, except in the case of some very large engines with multiple cylinders. This engine was designed and patented by Leon de Tissandier, M. E., a member of the Savage & Love Co., Rockford, Ill., who are the sole selling agents. It was made expressly for use with dynamos either direct connected or belted, for incandescent lighting in residences, country houses or hotels or for battery charging. Its uniformity of speed is remarkable under varying loads.



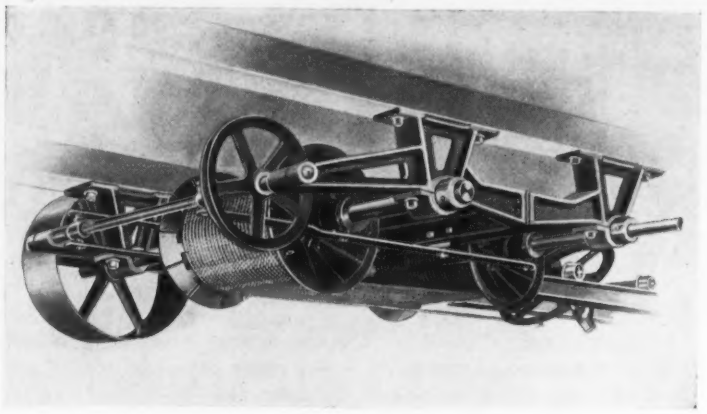
GAS ENGINE AND DYNAMO.

The engine may also be adapted for machine shop practice, or any other place where power is used with loads varying between wide limits. The engine is substantially made of the best materials in generous proportions; and by the use of special machinery it is possible to guarantee absolute interchangeability of parts. The machines are comparatively inexpensive. The manufacturers have had twenty years' experience in this class of work.

Variable-Speed Rope Transmission.

The use of rope for transmission purposes has of late years assumed a position of considerable importance. One of its chief advantages is that the relation between the two shafts, between which power is transmitted, is not fixed within such comparatively narrow limits as is the case with belt drives. This feature has been taken advantage of in the Sturgess variable speed rope transmission, which we illustrate. This transmission is used for driving paper and textile machinery, machine tools, etc., or for any other purpose where a speed-changing device is required.

In nearly all other forms of speed-changing devices short belts are used. It has also been a difficult matter to compensate properly for the variations in length of such belts, due to the fact that the length of a belt when passed around two expandable pulleys, the sum of whose diameters are constant, is not uniform unless the shafts are a great distance apart. Moreover, it has been a difficult matter to make a pulley which would expand or contract and give a positive



VARIABLE-SPEED ROPE TRANSMISSION.

driving diameter. The use of a rope on the American system, having a tension carriage, obviates, it is said, the above difficulties.

The transmission illustrated herewith has two shafts, each carrying a pair of cones, the hubs of which are embraced by collars attached to a pair of controlling levers, which are pivoted at a point midway between the two shafts. These levers are operated by a right and left hand screw, which may be rotated by a hand wheel, chain or rope wheel, or any other convenient connection designed for this purpose.

In the face of the cones are milled a number of dove-tailed slots which receive the dove-tailed ends of a number of segments, forming the periphery of the pulley. In these segments grooves are turned of proper shape to receive the rope. All the corners and edges where the ropes enter and leave the segments are well rounded off and smoothed. The thrust from the cones is received on large size ball bearings. The bearings being of the ring-oiling type the power absorbed by the transmission is small and its efficiency consequently high. The milling of the slots is an operation requiring great exactness and care, for which special machinery has been designed and constructed.

The speed variation obtainable is 5 to 1. As the pulleys are capable of high rotative speed considerable amounts of power can be transmitted with apparatus occupying comparatively small space. The transmission is made in hanger, standard or wall-bracket forms, in sizes from 1 hp to 150 hp. The tension carriage is constructed according to regular practice but may be arranged in a variety of ways to suit local circumstances. In the smaller sizes this is incorporated in the design of the counter shaft, in the larger sizes being made separate.

This transmission device is manufactured by the Sturgess Governor Engineering Company, of West Troy, N. Y., builders of the Sturgess water wheel governors.

Canadian Pacific Railway Shops, Montreal.

These shops are designed and equipped for work which does not vary in character and is adapted to the tools installed. Most of the latter are used for services that vary so little that they can be most economically operated by the constant-speed electric motors, which, in most cases, have been installed for them. The work in the machine shop has been divided into different general classes, such as wheel finishing, moving parts, like links, pistons, valves, etc., heavy turning, boring and planing. Brass finishing and other light work is done in the gallery and the erection of heavy parts is done in one of the side aisles. By this arrangement variable-speed motors have been dispensed with and in a total of about 200 electric motors only 15 are of variable speed.

The system adopted is three-phase, 600-volt current without transformers. This gives 550 volts at the motors and has the advantage of requiring about 10 per cent. less copper in the conductors. There are three 500-kw, three-phase, 600-volt and one 375-kw alternating generators made by the Canadian General Electric Company, each of them driven by a separate direct-connected 750-hp engine of new type Corliss valve gear, making 150 r.p.m. and built by the Robb Engineering Company, Amherst, N. S. All motors, except those otherwise mentioned, are of from 5 to 50 hp of the induction type, three-phase, 550-volt machines made by the Canadian General Electric Company. The fifteen direct-connected motors have a speed variation of 4:1 and are on the three-wire system, using 110 and 220-volt current. The contract for them has not yet been let, but will probably be awarded to the Canadian General Electric Company.

There is a standard three-phase switchboard with four generator distributing and exciter panels of the General Electric type. Outside wiring is done with overhead construction, bare copper main feeders running from roof to roof. In the building is a mixed system of open porcelain cleats and slow-burning waterproof wire on the ceilings, and Richmond conduits and rubber-covered wires on the side walls. Panel boxes are supplied, however, for every 10 kw of lighting and for every 100 hp of motor wire. There are 110-volt enclosed arc lamps of the Canadian General Electric make for shop illumination supplemented by standard 16-cp incandescent 110evolt lamps. There are approximately 400 arc lights and 3,800 incandescent lights in the yards and shops. In the passenger car shops the lights are spaced equi-distantly and low-tension arc lamps are installed on account of their economy and better results for general illumination. In the yards there are 50 enclosed series arc lamps of high potential.

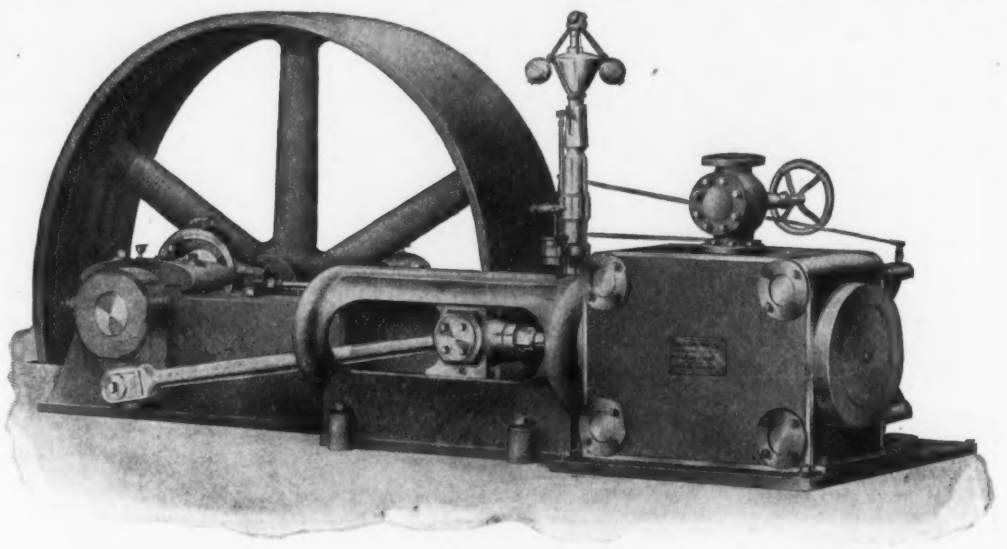
Yard transportation is provided by the 10-ton, 77-ft. span girder crane in the midway and the 10-ton, 57-ft. span girder crane at right angles to it, which distribute materials back and forth between the iron foundry and machine shop, and are each operated by three direct-current, 220-volt motors of 25 hp for the hoist and 8 hp for traversing. There is also a yard transfer table operated by a 20-hp, 550-volt motor. The shops are equipped with a complete telephone system for a 75-drop switchboard and 50 telephones, connected to the long-distance wires. They are metallic circuit, with motor-generators for ringing and self-restoring drops.

The electrical department of the Canadian Pacific Railway Company is installing all of the electrical wiring. The general office at the plant is wired throughout with conduit concealed work, and in every room there is a belt line of wire running around the oak walls near the ceiling behind oak molding which can be removed and a light connected to it at any point without disturbing the line. In the shops the small machine tools are arranged in groups, which, in most instances, are operated by a motor seated on an overhead platform between the roof trusses. As already noted, Mr. C. H. Hines has recently been appointed electrical engineer for the company. The Canadian Pacific is one of the most progressive railroad systems on this continent, and its present utilization of electricity in its shops is but another indication and proof of the fact. It has been rumored or understood that the company does not intend to stop short at equipping its Montreal shops with electric power, but will fit up other of its shops in like manner.

New Allis-Chalmers Standard Reynolds Corliss Engine.

We illustrate herewith a new Corliss engine which is being brought out by the Allis-Chalmers Company from the designs of Irving H. Reynolds. The field of Corliss engine design has been so fully worked over in the past, and the accepted designs have become so simple that no strikingly novel designs are to be expected. The present machine, however,, represents the experience of twenty-six years, and combines all of the desirable elements. Engines of the type illustrated are being built in seven sizes, ranging from 50 to 500 hp, and are designed for steam pressures up to 150 lbs. They are built of somewhat shorter strokes than have heretofore been customary in Corliss engines, with the idea of economizing in space and making the construction more rigid. The speeds are also somewhat higher than usual, ranging from 110 to 150 r.p.m., although these speeds are not higher than those at which the Reynolds-Corliss engines of older design are frequently operated.

The frame is cast in one piece with the slide, the construction being of the box type, resting on the foundation for its entire length. The main bearing shells are bored into the frame, thus insuring a solid bearing and also permitting the easy removal of the shells by rolling them out around the shaft. The slide is of the barrel type with bored guides. The crosshead is fitted with babbitt-faced shoes



CORLISS ENGINE.

with wedge adjustment. The piston rod is screwed into the crosshead and held firmly with a steel lock nut. The cylinder is of the round-cornered type, fitted with double-ported steam and exhaust valves, lagged with planished steel. The cylinder is set on a cast-iron base plate, which extends under the valve gear, serving as a drip pan.

The valve gear is of the usual Reynolds Corliss type, the wrist plate being of skeleton pattern and fitted with a new type of disconnecting device which, while clamping the hook rod firmly, is very easily detached by hand. The dash-pots are of differential plunger type without leathers or packing of any kind. The regulator is of the high-speed, weighted type, designed to control the engine within narrow limits of speed variation. The connecting rod is of steel with solid forged ends, fitted with bronze boxes, babbitt-lined on the crank-pin ends, the boxes being adjustable by means of screw actuated wedges. The crank is of plain type, polished on the face, and is protected by a planished steel oil guard, not shown in the cut.

The engines are fitted either with belt fly-wheels, as shown, or with square rim wheels where used with direct-connected generators. The crank and cross-head pins and main journals are of a size ordinarily used with heavy-duty engines.

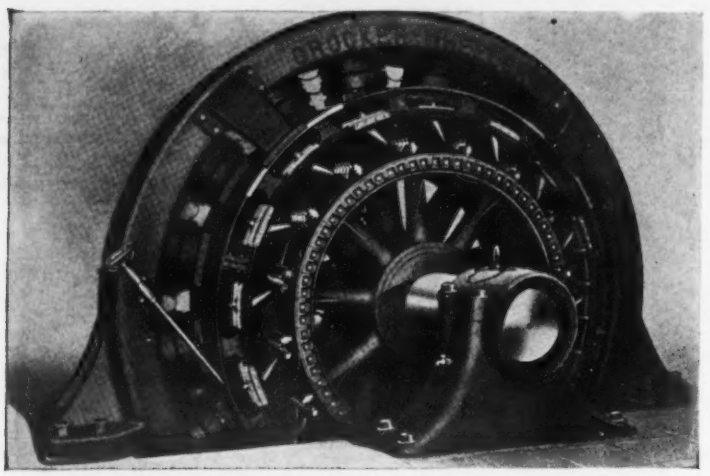
Stromberg-Carlson Rochester Plant.

The *Rochester Union and Advertiser* of November 13 gave an excellent illustrated description of the Stromberg-Carlson Telephone Manufacturing Company's plant in that city. The company is now enlarging this plant, and when the new building is completed the company will require the services of about 3,000 employees. Every modern facility for quick and economical production of apparatus in large quantities is being installed.

The Intramural Power Plant at the Louisiana Purchase Exposition.

One of the most interesting exhibits among many large and impressive power units in Machinery Hall at the Louisiana Purchase Exposition will be the electric generating equipment by the Crocker-Wheeler Company for the supply of power to the intramural railway. The plans for this plant provide for a generating capacity of 4,400 kw and the construction of the machine to furnish this power is well under way. This power will be supplied by eight units, each consisting of a standard Crocker-Wheeler railway type generator direct-connected to the prime-mover, the sizes being as follows: Two of 900-kw capacity, running at 100 r.p.m., one to be driven by a Borsig 1,500-hp gas engine and the other by a Buckeye horizontal cross-compound engine; three of 500-kw capacity, one to run at 100 r.p.m., and be driven by an engine built by the Murray Iron Works, and the other two to run at 135 r.p.m., and be driven by Brown Corliss engines; one of 400-kw capacity, to be driven at 150 r.p.m. by a Harrisburg horizontal tandem-compound engine, and one of 100-kw capacity, to be driven by a Doble water wheel at 700 r.p.m.

With the exception of the differences in size and details as to the proportions, the several generators are similar. The cast-iron magnet frame is of the internally-flanged type, parted on its horizontal diameter and bolted together by flanges on the inside. The poles are of mild steel cast-welded into the frame giving a minimum mag-



GENERATOR FOR INTRAMURAL RAILWAY, ST. LOUIS FAIR.

netic reluctance and a maximum strength. The field coils are made up in two or three sections which are individually wrapped, taped and insulated, and separated from one another by small wooden blocks to improve the heat radiating qualities. To allow the removing or replacing of the coils the pole shoes are detachable. The armature is of the iron-clad type, consisting of a toothed core of laminated mild steel in the slots of which the windings are protected by wooden wedges fitting in notches near the tips of the teeth. Very careful attention is given to the insulation, the formed conductors being bound and shellaced and the slots lined with heavy insulation.

The commutators are constructed of high-grade drawn copper with ample surfaces to carry current without undue heating and to give a large radiating capacity. Each brush rigging consists of a rocker ring held by brackets bolted to the field frame, which in turn supports brush holder arms with independent brushes on each. The brush holders are of the parallel movement type characteristic of the Crocker-Wheeler apparatus. On each one four sets of laminated copper strips carry the current and control the movement of the brush from or towards the commutator, always maintaining the same angle with its surface. This causes the brushes to wear away evenly, and as they become shorter allows them to be extended and clamped in a new position without altering the surface of contact. The brush pressure is regulated by a helical spring, which does not carry current, and hence is less inclined to heat and vary its tension. When desired, the brushes may be lifted from the commutator and held away from it by a half turn of the adjusting screw. This is a feature that is especially useful when it is expedient to test individual brush resistances, or certain windings for grounds. To compensate for any inequalities among the magnetic circuits, the brush holder arms may be shifted independently or to secure the position of sparkless commutation. When the various circuits are in equilibrium, the entire rocker ring may be revolved by the hand wheel.

The plant will be of interest not only to technical men, but to the public in general, as in it are contained the three prime-movers now used for the generation of electric power, steam, gas and water. The application of these units of motive power to generators of a variety of sizes will form a most interesting sight for exposition visitors.

Time Switch Box.

A compact and convenient form of time switch is shown in the accompanying cut, which illustrates the box of the Hartford Time Switch Company, of Hartford, Conn. It has a japanned iron case with double doors and is proof against dust and weather. The

TIME SWITCH BOX.

outer door is secured by a tumbler lock. It is wound once a week by an eight-day Seth Thomas clock mechanism. The switch automatically opens and closes the circuit at any predetermined time. When the automatic use of the switch is not desired, it can be instantly disconnected from the clock. The hand trip provides an independent means for operating the switch. The time for automatically operating the switch can be quickly and easily changed.

The switch is of the rotary, double-contact type, with quick break of approved length. The operation is entirely mechanical and no magnets are used. By a special attachment the Hartford time switch can be arranged to light show windows or signs for two periods each night.

Solid Expanding Sleeve.

An improved solid expanding sleeve which is specially adapted for fastening securely telephone backboards, etc., in brick, stone and cement, has been brought out by James S. Barron & Co., of 200-206

EXPANDING SLEEVE.

West Broadway, New York City. It is shown herewith. It is made of one piece, and is equally suitable for screws with wood or machine threads, and with any number of threads to the inch. A detailed description is not necessary.

Conduit Contract, Manchester, Mass.

G. M. Gest, of New York, Boston and Cincinnati, has been awarded the contract for the installation of a complete conduit system by the Manchester Electric Company, of Manchester, Mass., the ideal seaside resort of many of New England's best and wealthiest families, whose beautiful mansions are all that artistic and architectural design can accomplish, surrounded here and there by well-kept pretty farms, ranging in size from 50 to 100 acres each. The fact that so large a system is now being installed, requiring nearly a quarter of a million feet of conduit, and covering fifteen miles of streets, in what one might call a country residential place, is to say the least "unique."

NEWS OF THE WEEK.

Financial Intelligence.

THE WEEK IN WALL STREET.—Continued steadiness and strength characterized the railway stock market during the week, notwithstanding the dullness, persistent hammering and weakness in the neglected and less prominent industrial stocks, which were the principal objects of bear attacks. Money rates were firmer, but this had little effect on the general market. United States Steel shares were quiet. They acted independently of other industrials and efforts to depress them were less successful. The traction stocks were steady to strong with continued talk about a possible combination of such interests in Greater New York. Brooklyn Rapid Transit made a net gain of 1 point for the week's business, closing at 39½ after having touched 38⅜, the lowest point of the week. Metropolitan Street Railway also responded to the favorable influence and made a net gain of 2⅛ points, closing at 116⅝. The extreme quotations for this stock were 114, the lowest, and 117⅜, the highest. General Electric showed some weakness and closed at 154½, this being a net loss of ½ point. The lowest point was 152 and the highest 155⅛. Westinghouse common closed at 138, and preferred 170, the former being a net gain of 1 point. Western Union made a fractional gain, closing at 85⅛. Following are the closing quotations of December 1:

NEW YORK.

	Nov. 24	Dec. 1		Nov. 24	Dec. 1
American Tel. & Cable	77	75	General Electric	152¾	156
American Tel. & Tel.	125	126	Hudson River Tel.	..	..
American Dist. Tel.	26	25	Metropolitan St. Ry.	115⅝	117¾
Brooklyn Rapid Transit	38⅝	39¾	N. E. Elec. Veh. Trns.	..	..
Commercial Cable.	140	145	N. Y. & N. J. Tel.	..	..
Electric Boat	23	21	Marconi Tel.	..	..
Electric Boat pfd.	48	45	Western Union Tel.	84¾	88
Electric Lead Reduction	⅝	⅝	Westinghouse com.	137	140
Electric Vehicle	5½	5½	Westinghouse pfd.	167	170
Electric Vehicle pfd.	8	8			

BOSTON.

	Nov. 24	Dec. 1		Nov. 24	Dec. 1
American Tel. & Tel	25	126	Western Tel. & Tel. pfd.	79	80
Cumberland Telephone	*115	*115	Mexican Telephone	1⅛	1⅛
Edison Elec. Illum.	*241	241¼	New England Telephone	120	120
General Electric	152	155	Mass. Elec. Ry.	17½	19
Western Tel. & Tel	7¾	7⅛	Mass. Elec. Ry. pfd.	76	77

PHILADELPHIA.

	Nov. 24	Dec. 1		Nov. 24	Dec. 1
American Railways	41	40	Phila. Traction	95	95
Elec. Storage Battery	47	49	Phila. Electric	5⅞	5⅞
Elec. Storage Battery pfd.	47	49	Phila. Rapid Trans.	11⅛	11⅛
Elec. Co. of America.	..	7⅜			

CHICAGO.

	Nov. 24	Dec. 1		Nov. 24	Dec. 1
Central Union Tel.	..	..	National Carbon pfd.	87	87
Chicago Edison	..	..	Metropolitan Elev. com.	17	17
Chicago City Ry.	164	165	Union Traction	5	5
Chicago Tel. Co.	..	..	Union Traction pfd.	28	28
National Carbon	19	20			

*Asked

BELL TELEPHONE EXPENDITURES.—It has been estimated in Boston that the new cash requirements yearly for the American Telephone & Telegraph Company, i. e., the whole Bell telephone system, reach $30,000,000, and that this must largely or wholly be raised in New England. The *Boston News Bureau*, discussing this, says: "The Bell companies to-day are giving too good a service for money received; in other words, rates are too low, and they must be advanced. Then again, it must not be forgotten that the American Company issues stock upon which it pays 7½ per cent. dividends to take up securities which net the company an average of less than 6 per cent. The balance of its income must be made up from royalties, now reduced to a minimum, and from the earnings of long-distance lines and supplies. There are few people who correctly understand the instrument statement which the American Company issues each month. This statement in reality represents every instrument in use, including switchboard telephones and dead heads, and official telephones and many furnished at reduced rates. Two instruments are reported for each subscriber. On January 1, 1903, the company reported connected 1,277,583 telephone subscribers, and in the hands of licensees 3,150,320 instruments, but the subscribers using two each would utilize 2,555,976 of these instruments, showing 594,344 instruments not used by subscribers, or over 18 per cent. of the total amount outstanding. Most of these are probably subscribers' extension sets. Another large item in connection with the business not usually taken into consideration is the fact that in order to gain the use of 515,262 instruments, the net gain this year to date, the company had to put out 923,978 and take back 408,716. It has always been the experience of the licensee companies that in order to gain one subscriber they must put in two and take out one. It is certain that the tendency of telephone rates in this country is not downward, because the tendency is continually to increase the burden and work of the telephone. In some places, a few years ago, a telephone operator could attend to the calls of 75 or 100 subscribers; now the same operator can attend only to the needs of 25 subscribers, and in some places the calls of less than 10 subscribers have to be grouped together under one operator for proper attention."

U. G. I.—It is stated from Philadelphia that the declaration of a dividend of ¾ of 1 per cent. on Paterson & Passaic Gas & Electric stock is but the beginning of immediate and regular returns for the United Gas Improvement Company on several groups of its investments in Northern New Jersey gas properties. The Paterson & Passaic Gas & Electric dividend is made under guarantee, and dividends will this year also be declared on the stock of the Essex & Hudson Gas Company and the Hudson County Gas Company, under the terms of similar leases made with the same guarantor—the Public Service Corporation Company, of New Jersey. The interest of the United Gas Improvement Company in each of the three gas companies—the Paterson & Passaic Gas & Electric Company, the Hudson County Gas Company and the Essex & Hudson Gas Company is a majority of the stock, which, by the way, was received in consideration of its guarantee on certain underlying obligations. The dividends which the United Gas Improvement Company, as owner of a majority of the stocks of these three companies will receive are on an increasing sliding scale, and the importance of this item of guaranteed income is evidenced by the fact that at the maximum rates, or 8 years hence, the United Gas Improvement Company will receive from this source over $770,000 per annum. This is an amount equal to more than one-fourth the amount required to pay the 8 per cent. stock dividend on the entire $36,725,000 United Gas Improvement stock outstanding, or $2,938,000.

HARTFORD LIGHTING INTERESTS.—According to advices from Hartford, Conn., a deal by which the Hartford City Gas Light Company will shortly pass into control of the United Gas & Electric Company of New York, as a holding corporation, is nearly completed. A majority of the stockholders of the Hartford Company are said to have accepted an offer for the exchange of their stock, share for share, for the preferred stock of the holding company, with 20 per cent of the common stock of the new company thrown in. The stock of the Hartford Company is now $750,000, and is rated at 200. Under the proposed change, the holding company will have a capital of $1,500,000, of which one-half will be preferred stock on which a guaranty of 8 per cent dividends is given, and the other half will be common stock.

DIVIDENDS.—The Chicago City Railway directors have declared the regular quarterly dividend of 2¼ per cent., payable December 30. The first dividend that the San Francisco Gas & Electric Company has been able to pay since the time Claus Spreckels opened war upon it has been declared, it being at the rate of $2.50 per share, amounting in all to about $350,000. Now that "the cruel war is over," this corporation having bought up its rivals at an expense of many millions in bonds, new stock and cash, the company has an assured ample revenue, and the board of directors concluded that the giving of a dividend without further delay to the patient stockholders would be a good stroke of policy.

Commercial Intelligence.

THE WEEK IN TRADE.—Retail trade was stimulated in all seasonable lines by the continued cold weather. Manufacturing industry shows some weak spots. One hundred thousand cotton mill hands of Southern New England have quietly accepted lower wages; 15,000 employees of paper mills are idle at present, partly because of dull trade, but also because of low water in the streams, and in Colorado, Wyoming and Utah strikes, accompanied by violence, curtail production, limit industry and interfere with distribution. There are some favorable features among the industries, however. There is a better tone in iron and steel production, although shutdowns are numerous; foundry iron is in rather better demand and a good deal of iron has gone abroad as ballast for cotton ships. Finished products are rather dull and domestic buyers are somewhat reserved, but the extension of a reduction in railway freights to other lines of iron and steel give prospects of a large future export business. Other metals are dull, with copper and lead weak. In

copper prices further declined and there was no improvement in the demand. The official quotations, which have been reduced, are as follows: Lake, 12¾ to 13c.; electrolytic, 12⅝ to 12⅞c; casting stock, 12½ to 12¾c. Building is somewhat restricted on account of the advanced stage of the season; lumber is quiet for domestic trade, but export demand is active, and hardware continues good, all things considered. The business failures for the five business days ending with November 26, as reported by *Bradstreet's*, numbered 167, against 234 the week previous, and 182 the corresponding week of last year.

FREIGHT AND FOREIGN TRADE.—The Foreign Trade Association of America, which was chartered recently under the laws of the State of New York, to promote the export trade of the country, held its first regular meeting this week. The subject under discussion was the recent concession of 33⅓ per cent. granted to the United States Steel Corporation by the Trunk Line Association on freight rates on manufactured iron and steel products for export. The feeling among other manufacturers is that this is a discrimination against other classes of manufactured products, and resolutions were adopted calling for the appointment of a special committee, to be known as the Export Rate Committee of the Foreign Trade Association of America, authorized to employ independently the ablest counsel and rate experts and to collate information "tending to cause rates for export business to be reduced to a basis more in harmony with actual requirements." The following officers were elected, to serve until January 12, when the first annual meeting will be held and officers elected for 1904: President, Aristides Martinez, of Longman & Martinez; first vice-president, W. C. King, of the General Chemical Company; second vice-president, R. R. Fogel, of R. R. Fogel & Co.; treasurer, William M. Hollins, of H. B. Hollins & Co.; secretary, W. E. Simpson, editor of the *Banker and Miner of Mexico*. These officers also constitute the board of directors.

BELL TELEPHONE OUTPUT.—The American Telephone & Telegraph Company instrument statement for the month ended October 30 and since December 20 compares with the month ended October 30 and the period from December 20 in previous years as follows:

	1903.	1902.	1901.
Gross output	111,749	92,601	95,655
Returned	49,885	37,155	23,374
Net output	61,864	55,446	72,281
Since Dec. 20:			
Gross output	923,978	900,935	778,826
Returned	408,716	383,844	324,663
Net output	515,262	517,091	454,163
Total outstanding	3,665,582	3,042,697	2,406,979

RAILS FOR MEXICAN TRACTION COMPANY.—The Mexican Traction Company, of which M. R. McAdoo, 15 Wall Street, New York, is president, and in which James B. Oliver, Julius Bider, Reuben Miller, Sr., James H. Park and Frank B. Smith, of Pittsburg, are primarily interested, has awarded the contract to the Pennsylvania Steel Company for rails to be used in the construction of its lines in and around Mexico City. In addition to the Banos road and the various concessions which have already been noted in these columns, the company has received a franchise permitting of the building of 10 more miles of lines in the streets of the Mexican capital down past Chapultepec, to one of the principal suburbs. The power house equipment, as previously mentioned exclusively in ELECTRICAL WORLD AND ENGINEER, will be of Westinghouse manufacture.

AUTOMOBILE TRADE.—It would appear that statistics from 85 per cent. of the automobile manufacturers in the United States to September 3 indicate that the actual sales for the year 1903 will be 11,000 cars, valued at $12,000,000. This is double the business of 1902, to which must be added the foreign importation of 200 cars valued at $800,000. The importation of foreign cars is about the same as last year. Trade in foreign-made cars is probably at its maximum and will slowly decline, as the American manufacturers are rapidly supplying the demand. It is predicted that the business of 1904 will double that of this year. Just how large a percentage of this business consists of electric automobiles is not known. Some estimate it at only 10 per cent., or say $2,000,000 a year, which seems high or low, depending on the point of view.

NEW ENGINEERING AND CONTRACTING FIRM.—The electrical engineering and contracting firm of Muralt & Co., 25 Pine St., N. Y., has been formed for the purpose of handling contracts for alternating-current work and for the electrification of steam roads. The firm includes Carl Leonard de Muralt, formerly associated with the General Electric Company; Union Elektricitäts Gesellschaft, of Berlin, and Brown, Boveri & Co. His partner is Ellwood Hendrick. The new concern proposes to make a specialty of export trade, particularly in Mexico and South America, and is already figuring on some substantial contracts for the equipment of hydro-electric plants. They will act as representatives for Brown, Boveri & Co. on this side.

WIRING FOR HOSPITAL BARRACKS.—Sealed proposals, subject to the usual conditions, will be received until 3 p. m., December 23, 1903, for furnishing the labor and material for the construction, pumping, gas piping, heating and electric wiring of a brick hospital at Whipple Barracks, Arizona. Plans, specifications and other information can be had there, and in the offices of the Chief Quartermaster, San Francisco, Cal., and Denver, Colo., and Constructing Quartermaster, Fort Leavenworth, Kan. Envelopes containing proposals should be indorsed "Proposals for Hospital at Whipple Barracks, Arizona," and addressed to Charles C. Walcutt, Jr., Constructing Quartermaster.

SAO PAULO SYSTEM TO BE EXTENDED.—The Sao Paulo Tramway, Light & Power Company, Limited, is about to extend its operation in Sao Paulo, Brazil. Further equipment is to be installed in the large hydraulic plant on the Rio Tiete, which has Stilwell-Bierce & Smith-Vaile turbines and General Electric generators. The company has made an offer to the municipality of Sao Paulo with a view to constructing cold storage plants. The company, which is composed of Canadian capitalists chiefly, William Mackenzie being president, will find all the necessary capital. The plant, it is proposed, will revert to the municipal authorities without charge, at the expiration of twenty years.

LOOMIS-PETTIBONE.—The Loomis-Pettibone Gas Machinery Company, 52 William Street, New York, has decided not to begin construction operations for the present at the huge plant which it was contemplated to build at Elizabeth, N. J. The Crossley (British) gas engines, which the Loomis-Pettibone people have the American rights to build, will be turned out in the meantime, at the Holthoff Machinery Company's plant at Cudahy, Wis. This concern is controlled by the Loomis-Pettibone Company. The Cudahy plant will be extended at a cost of some $150,000. The company is negotiating for the installation of some large gas engines in Mexican mines.

CONDUIT FOR BELGIAN AND RUSSIAN TELEPHONE SYSTEMS.—The H. R. Camp Company, of Aultman, Ohio, has just secured an important contract for single conduit for the Brussels (Belgium) telephone and telegraph system. The contract was secured through G. Ernest Woodman, of 27 Chancery Lane, London, a partner of Jabes F. Cummings, who is now in St. Petersburg superintending the laying of the conduit for the municipal telephone and telegraph system. Some 1,500 tons of the conduit have already been shipped from the Raritan (N. J.) plants controlled by the National Fire-Proofing Company.

MORE ELECTRIC TRACTION FOR HONOLULU.—The Honolulu Rapid Transit & Land Company, which operates about 20 miles of electric lines in Honolulu, has acquired the Hawaiian Tramways Company's horse car system, 12 miles long. The latter is a British enterprise. Part of the existing lines will be immediately converted to electric motive power. The general manager and purchasing agent of the new interests is W. H. Pain. His headquarters are in Honolulu.

CANADIANS IN MEXICO.—With reference to negotiations already noted in this department a dispatch from the City of Mexico says that the large electric light and power plant and franchise of the Siemens-Halske Company, of Berlin, in the City of Mexico, has been acquired by the Mexican Light & Power Company. The latter is composed of Canadian capitalists who are building a greater electric generating plant and transmission lines near the City of Mexico.

LIGHT RAILWAY FREIGHT YARDS.—MacKenzie, Quarrier & Ferguson, 114 Liberty Street, New York, have secured a contract from the Pennsylvania Railroad for a 300-hp tandem compound Harrisburg engine for direct connection to a Sprague 200-kw. generator. The outfit is to be utilized for lighting the freight yards at Greenville, N. J. A contract is expected to be closed within the next few days for a good-sized lighting outfit to be shipped to Australia.

EQUIPMENT FOR NATIONAL FIRE-PROOFING PLANT.—The National Fire-Proofing Company, Broadway, Maiden Lane Building, New York, is to electrically equip its new Raritan (N. J.) plant, which is located two miles above Perth Amboy, and was formerly known as the Raritan Hollow Porous Brick Plant. The plant was burned down last summer. The contracts will be let through the general superintendent, Mr. J. C. Rossi.

ENGINE FOR INDIAN LIGHTING PLANT.—The Reeves Engine Company, of Trenton, N. J., has been allotted an order by the Union Trading Company, of Madras, India, for a 300-hp vertical cross compound engine for direct connection to a 200-kw. generator, for installation in a lighting plant.

SUPPLIES FOR GERMANY AND JAPAN.—The export commission house of Richter, Otten & Co., 81 Pine Street, New York, has a number of fair-sized orders and inquiries in hand for electrical supplies, etc., for shipment to Germany and France.

MORE TROLLEY FOR NEW YORK.—The Metropolitan Street Railway Company desires to operate with the trolley on the West Street water front of New York City, but must obtain the consent of two-thirds of the abutting property owners, and Mr. Hawkes, as Dock Commissioner, in behalf of the city, has power to give consent for all the water front property. The company claims that sub-surface conduits are impracticable under West Street because of the tide. It has sent to property holders a circular letter setting forth its attitude in the matter, and telling what it has done in an attempt to improve the service. It is stated that after trying storage battery cars and compressed air cars without success, the company offered a reward of $50,000 for an available system, but was unable to secure one. Permission is asked for the installation of a system of cars which can be fitted with both overhead and underground trolley. It is objected that the overhead wires might be troublesome on West Street, inasmuch as that is one of the most crowded thoroughfares in the city, with thousands of pedestrians and array of heavily laden trucks, some with burdens piled as high as fifteen feet from the pavement. As to the effect of the tide upon an underground trolley conduit, it is pointed out that the mean average tide rise is five feet along West Street, but there have been records of nine feet.

TRACTION IN ST. LOUIS.—The Western Electric Company, of St. Louis, well known in the electrical manufacturing and supply field, has applied for a franchise in the city of St. Louis for an elevated subway railway. This road will run from Third and Washington Avenue, underground, to between Seventeenth and Nineteenth streets, where it will then come out above the surface in an elevated, west to the city limits, terminating on the Watson Road. The route of the present franchise asked will be from Third and Washington Avenue under St. Charles Street, to probably between Seventeenth and Nineteenth Streets, then in an elevated structure over St. Charles Street, Bell and Fairfax Avenues, west to Taylor Avenue and south over Taylor to Manchester Avenue, then west over Manchester, Clayton, Berthold, Billon and McCausland avenues to the city limits on the Watson Road.

THE CHICAGO SUBWAY.—President Wheeler, of the Illinois Telephone & Telegraph Company says: "We are pushing the construction of our tunnels and rails in the downtown district post haste, as we wish to commence delivery of freight to wholesale houses, etc., by July 1, 1904. Few people realize the vastness of our enterprise. Thirty railroads enter Chicago within a radius of 1½ square miles, and the freight cars of this giant aggregation of roads will run along our tunnels. It is a novel enterprise taking the place in Chicago of the East and North rivers in New York. In our telephone department we are only aiming at the moment to give an entirely private service to business men. We have installed 2,500 telephones up to date. When our tunnel system is complete we shall have 20 miles of rails laid."

CANADIAN CORUNDUM.—The Corundum Refineries Company has been organized at Buffalo with $1,000,000 capital to work large deposits of corundum found near Toronto. Buffalo will be the headquarters of the concern. The incorporators and officers are John N. Scatcherd, Buffalo, president; John H. Tilden, Hamilton, Ont., vice-president; John E. Conway, Buffalo, treasurer; J. H. Jewel, Toronto, secretary; Charles R. Huntley, of the Buffalo General Electric Company; William H. Rankine, of the Niagara Falls Power Company; James A. Roberts, New York; W. Van Duzen and H. H. Dewart, Toronto, and H. P. Coburn, Hamilton, directors. The output of the company's mines for the first two years has been taken up already, it is said, in Boston.

NEW YORK CENTRAL ORDERS.—A number of details were given in these columns last week as to the order placed by the New York Central Railroad with the General Electric Company for eight turbo-generator units of 7,500 hp., and 30 electric locomotives of 2,200 hp. each. Mention was also made of the order for Babcock & Wilcox boilers. We were able to illustrate the turbo-generators, giving dimensional details. These 8 will be raised to 10 or 12 ultimately, for the two proposed power plants. The boiler order will reach a capacity, it is said, of 48 boilers, each of 628 hp, or a total of 30,144 hp. They will be equipped with super-heaters; and Worthington surface condensers have been ordered from the International Steam Pump Company of New York.

AUTOMOBILE SHOW.—According to the list issued the Automobile Show, to be held at Madison Square Garden January 16 to 23, promises to be the greatest industrial exhibition ever held in that building. The demand for space required a special allotment by Frank W. Sanger, of the Madison Square Garden Company; S. A. Miles, of the National Association of Automobile Manufacturers, and General George Moore Smith, of the Automobile Club of America, who had the matter in charge. There will be 152 exhibitors, occupying 239 spaces. No one concern is given more than four spaces. Of this number eighty-eight are builders of complete vehicles. About fifty concerns were unable to secure space.

PLANT FOR YTU, BRAZIL.—A contract has been entered into by the Light & Power Company, of Ytu, Brazil, for the installation of an electric transmission plant for the power house on the River Tiete, at a place called Cachoeria das Lavras, situated about one kilometer from the center of Ytu. The hydraulic machinery is to be furnished by the Lidgerwood Manufacturing Company, and the electric machinery by the Westinghouse Electric & Manufacturing Company. A. W. Foster is consulting engineer, Dr. Luiz Marinho de Azavido electrician, and Franklin Hatch hydraulic engineer for the Lidgerwood Manufacturing Company.

GAS ENGINE AND GENERATOR FOR JAPAN.—The Mackay Engineering Company, Singer Building, N. Y., has been awarded a contract for equipment to be installed in a plant at Kobe, Japan. The engine will be a Walrath gas one of 125 hp capacity, built by the Marinette (Wis.) Iron Works Manufacturing Company. It will operate on illuminating gas, and will be direct connected to a generator of 75 kw. capacity, made by the Akron (O.) Electric Manufacturing Company. The Mackay people anticipate the closing in their favor within the next week or so of three contracts for lighting equipments for Santiago, Cuba.

GOULD STORAGE BATTERY ORDERS.—The Gould Storage Battery Company, New York City, Mr. W. W. Donaldson, sales manager, reports the following recent orders: New York, New Haven & Hartford Railroad Company, two plants of 55 cells each, to be used for lighting the stations at Bristol and New Britain, Conn. These installations are replacements of batteries of other makes. Narragansett Electric Lighting Company, Providence, R. I., positive plates with an aggregate capacity of 320,000 amp.-hours as replacement of the original installation of other makes, which have been in use for some years.

SUPPLIES FOR THE LONDON COUNTY COUNCIL.—Birck & Hickman, of Whitechapel Road, London, which concern represents the British interests of several American manufacturers of machinery, supplies, etc., and is one of the largest handlers on the other side, has been chosen, among others, to supply the London County Council with electrical supplies for the coming year. As the L. C. C. is constructing extensive lighting and power plants, etc., in the British metropolis and suburbs the orders which will eventually reach manufacturers on this side are likely to be very gratifying.

SOME INTERESTING CUTTER ORDERS.—The Cutter Electric & Manufacturing Company, of Philadelphia, has just taken a large contract for triple-pole circuit breakers and Keystone instruments for direct current. The equipment is intended for the light and power plant at the St. Louis Exposition. Another interesting order calls for 150 individual arm circuit breakers with hand switches for the large switchboard, which the H. Krantz Manufacturing Company, of Brooklyn, is building for installation in the Metropolitan Life Building, Madison Square, New York.

SOME MAGNET WIRE ORDERS.—The Magnet Wire Company, 80 William Street, New York, has just been awarded a contract by the Interborough Rapid Transit Company for a 1,500,000 c.m. cable. The Pittsburg (Pa.) Railways Company has ordered a good-sized lot of No. 00 trolley wire. The San Antonio (Texas) Traction Comapny has requisitioned for a fair-sized quantity of No. 0, and the Chambersburg, Greencastle & Waynesboro (Pa.) Street Railway Company is to be supplied with a considerable lot of weatherproof fire and trolley wire.

THE NORTHERN ENGINEERING WORKS, crane builders, Detroit, Mich., report among recent sales electric cranes of from 5 to 25 tons capacity to the following firms: Gerst Brothers, St. Louis; Olds Gasoline Engine Works, 3 cranes; Omaha & Council Bluffs Railway Company; American Steel & Wire Company; Green's Car Wheel Company, and hand-power cranes of equal capacity to Cambria Steel Company, Jackson & Church, Indianapolis & Cincinnati Traction Company, besides several other smaller electric and hand-power cranes.

TRUMBALL SPECIALTIES FOR THE PACIFIC SLOPE.—The Trumball Electric Manufacturing Company, 136 Liberty Street, under the management of J. D. Watson, reports receipt of substantial orders for its specialties—switches principally—from Los Angeles, San Francisco, and other points on the Pacific slope. The company is bringing out a new cord adjuster and pendant switch, for which there are several orders waiting.

MINE ELECTRIC HAULAGE.—The Blackwood Coal & Coke Company, of Blackwood, Wise County, Va., is contemplating the installation of a 400-kw. three-phase, 6,600-volt system for distribution to rotary converters for electric haulage, etc., in its mines recently opened up at that place. Mr. J. Blaine Replogle has accepted a position with the concern as electrician.

DIRECTORY OF ELECTRICAL ASSOCIATIONS, SOCIETIES, ETC.

(Published first issue of each month.)

American Electrochemical Society. Secretary, C. J. Reed, 929 Chestnut Street, Philadelphia, Pa. General meeting, Washington, D. C., April 7, 8 and 9, 1904.

American Electro-Therapeutic Association. Secretary, Dr. C. E. Skinner, New Haven, Conn.

American Institute of Electrical Engineers. Secretary, Ralph W. Pope, 95 Liberty Street, New York. Meetings, last Friday each month.

American Railway, Mechanical & Electrical Association. Secretary, Walter Mower, 12 Woodward Ave., Detroit, Mich.

American Society of Municipal Improvements. Secretary, G. W. Tillson, Brooklyn, N. Y. Next meeting, St. Louis, 1904.

American Street Railway Association. Secretary, T. C. Pennington, 2020 State Street, Chicago.

Association of Edison Illuminating Companies. Secretary, W. S. Barstow, New York City and Portland, Ore.

Canadian Electrical Association. Secretary, C. H. Mortimer, Toronto, Ont. Next meeting, Hamilton, Ont., 1904.

Chicago Electrical Association. Secretary, W. B. Hale, 242 South Jefferson Street, Chicago.

Colorado Electric Light, Power & Railway Association. Secretary, George B. Tripp, Colorado Springs, Col. Annual meeting last Wednesday in October.

Connecticut State Street Railway Association. Secretary, E. W. Poole, Bridgeport, Conn. Annual meeting in November.

Engine Builders' Association of the United States. Secretary, F. P. Ide, Springfield, Ill. Next meeting, December, 1903.

Electrical Trades Society (Member National Electrical Trades Association). Secretary, A. P. Eckert, 39 Cortlandt Street, New York. Board of Directors meets second Friday of each month.

Illinois State Electric Association. Secretary, H. E. Chubbuck, LaSalle Ill.

Indiana Public Utilities Association. Secretary, A. M. Barron, Indianapolis, Ind.

Independent Telephone Association of the United States. Secretary, Frank G. Jones.

Independent Telephone Association of Southern Indiana. Secretary, E. W. Pichardt, Huntingburg, Ind.

International Association of Municipal Electricians. Secretary, Frank P. Foster, Corning, N. Y.

Interstate Independent Telephone Association. Secretary, E. M. Coleman, Louisville, Ky. Next meeting, Chicago, Ill., December 8, 9 and 10, 1903.

Iowa Electrical Association. Secretary, W. S. Porter, Eldora, Ia.

Iowa Telephone Association. Secretary, C. C. Deering, Des Moines, Ia. Annual meeting, Des Moines, March 8, 1904.

Kentucky Independent Telephone Association. Secretary, James Maret, Mount Vernon, Ind.

Maine Street Railway Association. Secretary, E. A. Newman, 471 Congress Street, Portland, Me.

Massachusetts Street Railway Association. Secretary, Charles S. Clark, 70 Kilby Street, Boston, Mass. Meets second Wednesday of each month, except July and August.

National Arm, Pin & Bracket Association. Secretary J. B. Magers, Madison, Ind. Next meeting St. Louis, July, 1904.

National Electrical Contractors' Association of the United States. Secretary, W. H. Morton, 44 Whitesboro Street, Utica, N. Y. Next meeting St. Louis, Mo., September 14, 15 and 16, 1904.

New England Street Railway Club. Secretary, J. H. Neal, 101 Milk Street, Boston, Mass. Meets last Thursday of each month.

New York Electrical Society. Secretary, G. H. Guy, 114 Liberty Street, New York.

National Electric Light Association. Secretary, Ernest H. Davis, Williamsport, Pa. Next meeting, Boston, Mass., May or June, 1904.

Northwestern Electrical Association. Secretary, T. R. Mercein, 85 Michigan Street, Milwaukee, Wis. Next meeting, Milwaukee, Wis., Jan. 20, 1904.

Ohio Street Railway Association. Secretary, Chas. Currie, Akron, Ohio.

Ohio Electric Light Association. Secretary, D. L. Gaskill, Greenville, Ohio.

Ohio Society of Mechanical, Electrical and Steam Engineers. Secretary, C. J. Miller, Canton, O.

Southwestern Electrical Association. Secretary, J. L. Ellis, Oklahoma City, Okla. Next meeting, Dallas, April or May, 1904.

Southwestern Gas, Electric & Street Railway Association. Secretary, Frank E. Scovill, Austin, Texas.

Street Railway Accountants' Association of America. Secretary, W. B. Brockway, 40 Morris Street, Yonkers, N. Y.

Street Railway Association of the State of New York. Secretary, W. W. Cole, Elmira, N. Y. Next meeting, Utica, N. Y., Oct. 11 and 12, 1904.

United Electrical Contractors' Association of New York State. Secretary, William J. Davis, Ithaca, N. Y. Next meeting, New York City, January 19, 1904.

Vermont Electrical Association. Secretary, C. C. Wells, Middlebury, Vt.

General News.

THE TELEPHONE.

NASHVILLE, ARK.—A new switchboard and the addition of 50 miles of toll line is contemplated by the Nashville Telephone Company. Eureka apparatus is used here, and there are 185 subscribers, who pay $1.50 per month for residence and $2 for business service.

WASHINGTON, D. C.—It is understood that an agreement has just been reached between the Telephone Subscribers' Association of the District and the Chesapeake and Potomac Telephone Company, by the terms of which the proceedings instituted several years ago to enjoin the telephone company from refusing service to those who declined to pay rates higher than those prescribed by the act of Congress of June 30, 1898, will be discontinued.

INVERNESS, FLA.—Seventy-two subscribers are furnished with service by the Florida Telegraph & Telephone Association. The company proposed building 25 additional miles of toll line in the near future.

ATLANTA, GA.—The Southern Bell Telephone Company has petitioned the City of Atlanta for the privilege of placing its wires underground on a number of the principal streets.

ROBERTS, ILL.—The Lyman Telephone Company has been incorporated with a capital stock of $5000. The directors are C. Anderson, F. S. Diller and G. W. Madden.

GIBSON CITY, ILL.—The Gibson Home Telephone Company has been incorporated to operate a telephone and telegraph system; capital, $25,000. Incorporators: A. L. Phillips, B. G. Schlosser, H. A. Hall.

PANA, ILL.—A company of local capitalists, consisting of Warren and C. T. Penwell and B. Beckenheimer, has bought controlling interest in the Pana & Christian County Telephone Company, with a mileage of 25 miles. Mr. Beckenheimer is president.

DE WITT, ILL.—The Farm & City Telephone Company has recently closed a contract with the Interstate Telephone & Telegraph Company to secure connection with Springfield, Peoria and all northern and western cities. The Farm & City Company operates 6 exchanges with 1000 subscribers, and expects to change all its circuits to metallic. It expects a growth of 40 per cent in the near future. It uses Sterling apparatus. Mr. B. F. Wasson is president.

LASANTVILLE, IND.—Steps have been taken in this city to displace the Bell telephone system by installing an independent system.

EVANSVILLE, IND.—The Cumberland Telephone Company has reduced its rates for residences for individual metallic circuit with long distance equipment from $3 to $2.50 per month; two-party line, same equipment, $2 per month.

INDIANAPOLIS, IND.—The Mitchell Telephone Company has filed articles of incorporation. The capital stock is $30,000. The principal office and exchange will be in Mitchell. L. W. Spencer, Wm. McKeane, A. H. Hostetter, C. W. Coleman and Wm. Raney are the incorporators.

RENSSELAER, IND.—The largest farm in Indiana is owned and operated by B. J. Gifford and contains 32,000 acres in the northern part of Jasper County. In addition to twelve miles of railroad, his own engine and cars to draw his produce to Chicago, he maintains village stores, warehouses, cold storage plants (schools by public money), churches and over 350 tenement houses, all of which are connected by a complete system of telephones which in turn is connected with the long-distance lines.

TERRE HAUTE, IND.—One of the principal questions discussed by the delegates to the Municipal League Convention held in this city last week was the power to compel companies to bury their wires in the absence of a provision in the franchise. An attempt is being made by the authorities of Richmond and other cities in Indiana to compel electric companies to place their wires underground. The opinion prevailed that the companies can be compelled to bury their wires whether it is provided in their franchise or not. The cost of putting wires underground in a territory covering one square mile was estimated to be about $45,000. A number of Indiana cities have added a clause to the franchise granting an extension providing for the placing of wires underground. In Ft. Wayne, Terre Haute and Indianapolis the franchises provided for placing wires underground. South Bend has a district of four square miles in which the wires are underground.

RIVERTON, IA.—Local parties propose to buy the telephone exchange or construct a new system.

SIOUX CENTER, IA.—The Hawarden Telephone Company has been granted a franchise for a telephone exchange.

MARSHALLTOWN, IA.—A farmers' mutual telephone company has been organized at this place with D. N. Blair as president.

MILLER, IA.—The Ellington Telephone Company has been formed in Ellington township to build a telephone line to Miller.

PALMER, IA.—The Farmers' Mutual Telephone Company proposes a line from Pomeroy to Pocahontas and connect with Palmer and Rusk.

WATERLOO, IA.—The United States Telephone & Telegraph Company will rebuild the local telephone exchange at a cost of $100,000. Cable has been ordered for the work.

SIOUX CITY, IA.—The Sioux City Telephone Company will expend $350,000 in installing a local system, erecting a three-story fireproof exchange building, putting in a conduit system, etc.

WATERLOO, IA.—The Waterloo City Council has granted R. A. Davidson a 20-year franchise to operate an independent telephone system in this city.

ALBION, KAN.—The Albion Telephone Company has been incorporated with a capital stock of $1000.

OWINGSVILLE, KY.—The Owingsville Telephone Company is being formed by local people and an exchange will be installed some time in the near future.

PORT JEFFERSON, N. Y.—The North Shore Telephone Company, with a capital of $7500 was organized by electing the following directors: Frank H. Tuthill, of Rocky Point; W. A. Davis, of Mount Sinai; Postmaster C. A. Squires, of Echo; J. H. Davis, H. T. Bayles, John E. Overton, Charles V. Platt and Ralph J. Hawkins, of Port Jefferson, and Thomas N. Bayles, of Stony Brook. It is proposed to run a local line from Smithtown to Wading River, with a central at Port Jefferson, and give an unlimited service to all subscribers, except business places, at $10 a year. Business places will be charged $15.

NEWBERRY, MICH.—The council has granted a franchise to the Michigan Telephone Company which will install an exchange. The project for a municipal telephone system has been abandoned.

HOKAH, MINN.—The Hokah & Mound Prairie Telephone Company has been organized here and will soon commence the construction of a farmers' telephone line into Hokah.

GILLAM, MO.—The Gillam Telephone Company has been incorporated with a capital stock of $2500. The directors are W. T. Swinney, R. N. Ayers and others.

LAWRENCE, NEB.—The Lawrence Telephone Company, of Lawrence, has filed articles of incorporation with the secretary of state. The capital stock is $1000. The company will operate a telephone system in Nuckolls and adjoining counties.

STEUBENVILLE, OHIO.—The Island Creek Telephone Association has been organized here by the election of D. S. Carr as president.

URBANA, OHIO.—The Urbana Telephone Company contemplates extensive improvements. The switchboard capacity is to be enlarged and new telephones installed.

ZANESVILLE, OHIO.—The Zanesville Telephone Company has been incorporated with a capital stock of $10,000. The directors are J. B. Rhoads, S. M. Winn and others.

PLEASANT HILL, OHIO.—The Pleasant Hill Telephone Company operates a 100-drop American switchboard, and has 125 subscribers. Some additional farmers' lines are projected.

LORAIN, OHIO.—The council has granted a franchise to the Ohio Telephone & Telegraph Company to install a Bell exchange here in opposition to the established independent company.

CEDARVILLE, OHIO.—The Cedarville Telephone Company has elected these directors: R. E. Kerr, O. E. Bradfute, F. W. Turnbull, J. H. Andrew and D. Bradfute. The company is planning improvements to its system.

ROCKFORD, OHIO.—The Rockford Toll Line Telephone Company is operated in connection with the Rockford Telephone Exchange Company, which latter has 160 subscribers. The company uses a 200-drop Sterling switchboard.

MEDINA, OHIO.—A Eureka 350-drop switchboard is operated by the Medina Telephone Company, which has 300 subscribers. The recent growth of the company has been good, and Mr. W. B. Croft, the secretary, reports a fair outlook.

CAMBRIDGE, OHIO.—The Cambridge Home Telephone Company's switchboard capacity is 200 drops (American type) and 600 lamps (North). There are 550 subscribers, who pay $18 and $24 per annum each. The company owns 70 miles of toll line.

CROOKSVILLE, OHIO.—The newly organized Crooksville Telephone Company has elected the following officers: J. B. Rhoades, president and general manager; H. A. Skidmore, secretary, and Wm. Harris, treasurer. The company has secured a large number of subscribers and is planning to purchase material and install an exchange in the near future.

MANSFIELD, OHIO.—Mansfield people have bought about $200,000 worth of the stock of the Mansfield Telephone Company heretofore owned by the Federal Telephone Company, of Cleveland. The officers of the company are S. N. Ford, president; J. L. Baxter, vice-president; M. D. Ward, secretary-treasurer. The company is doing a very extensive business and it is the intention of the new owners to make important improvements.

TILLAMOOK, ORE.—The Tillamook Telephone & Telegraph Company has 161 miles of toll line, with several more to be built. The exchange at Tillamook operates Eureka apparatus and has 180 subscribers. The demand for telephone service is very good, almost greater than the company is able to supply.

RURAL VALLEY, PA.—The Armstrong Telephone Company operates an exchange at Rural Valley and one at Dayton, Pa. J. H. Foster is superintendent.

APOLLO, PA.—There are 175 subscribers to the service given by the Apollo Telephone Company, which uses Stromberg-Carlson apparatus. It charges $1.50 per month.

CARMICHAELS, PA.—The Carmichaels Telephone Company reports a steady increase of business. It is contemplating extending its lines. At present there are 160 subscribers. A North switchboard and Stromberg-Carlson telephones are used. The rates are $12 and $18.

CORAOPOLIS, PA.—A Kellogg 150-drop switchboard is in operation here by the Pittsburg & Allegheny Telephone Company. Two new trunk lines to Pittsburg are projected. Unlimited service to all exchanges in Allegheny County is included in the annual charge of $58 for residences and $72 for business. Mr. George Jackson is general manager of this exchange.

BEDFORD, PA.—In three years the Bedford County Telephone Company has paid for itself and made improvements. It is contemplating a line of 13 miles to Hyndman, connecting with western Maryland, giving it Cumberland and 1500 subscribers on its line. The growth of the company has been very rapid, and it numbers at present 350 subscribers, who pay $12 per annum each.

JOHNSTOWN, PA.—The Johnstown Telephone Company has 2000 subscribers. The system has been growing at the rate of 500 subscribers per annum. Kellogg apparatus is employed. The company is building the Pittsburg-Johnstown Long Distance Telephone Company's lines, under the direction of Mr. William S. Paca. This line it is expected will be completed by December 15, 1903.

CAMBRIDGE SPRINGS, PA.—Four hundred subscribers and the investment paying 10 per cent. is the record of the Cambridge Springs Telephone & Telegraph Company, which was organized seven years ago. Cambridge Springs has a population of 2000, and has connection with Cleveland and Olean. It expects to have long-distance connection with Buffalo soon. Ten miles of toll line are projected.

PROVIDENCE, R. I.—Important alterations in the central exchange of the Providence Telephone Company on Union Street are under consideration. Its capacity will be doubled or trebled; the common battery system will be adopted and at least two stories will be added to the present building, making five stories available for telephone purposes, excepting the first floor on the front which will be occupied by storekeepers.

WHITE LAKE, S. D.—Local men are arranging to establish a telephone system at this place. The improvement is much needed as this is the only town between Mitchell and Chamberlain that has no telephone system.

WEBSTER, S. D.—Starting with 75 subscribers two years ago the Webster Telephone Company now numbers 235 in the city and 85 in the country. A 300-drop Kellogg board is operated.

YANKTON, S. D.—The Farmers Co-operative Telephone Company has been formed by the farmers of the northern part of Yankton County. The officers are Hon. John M. Larson, president; Hans Hanson, treasurer; Albert Klath, secretary. The company has purchased the lines now in operation between Center Point and Viborg and expects to further extend the lines until the farmers of the entire northern part of the county are connected.

SAN ANGELO, TEX.—From 85 subscribers to 395 to-day and from no toll lines to 550, in four years, is the record of the San Angelo Telephone Company. A Kellogg switchboard of 610 drops capacity is installed at this exchange.

NAVASOTA, TEX.—The Navasota Telephone & Construction Company operates in Grimes County. Stromberg-Carlson instruments are used; there are 175 subscribers, who pay $3 for business and $1.50 for residence service per month.

RICHARDSON, TEX.—A meeting has been called of the stockholders of the Richardson Telephone Company for the purpose of selling its exchange to one man, as it is believed this will be more satisfactory than the mutual plan under which the company has been working. There are 90 subscribers with prospects of a steady increase.

WAXAHACHIE, TEX.—The Ellis County Independent Telephone Company operates exchanges at Ennis and Waxahachie. The two exchanges are connected by toll lines. Business in Ennis is always good, the exchange there having 400 subscribers. The Waxahachie exchange numbers 340 subscribers. The company has toll connection with every post office in the county, also lines to Ft. Worth, Cleburne, Hillsboro and Waco (Tex.), aggregating some 300 miles.

PRICE, UTAH.—Six switchboards, two of which will have a capacity of 500 drops, will be installed within the next three months by the Price Telephone Company. The lines of this company take in Carbon and Emery Counties. Fifteen miles of toll line are to be added to the system.

FAIRVIEW, UTAH.—The Fairview Telephone Company has in view a consolidation with a system in Castle Valley. This would give the consolidated company a system of considerable importance.

PETERSBURG, VA.—Considerable extension of toll lines is planned by the Petersburg Telephone Company. This company was organized in 1902 and has now 820 subscribers. It has recently purchased valuable real estate on the principal business street and as soon as the lease on the present location expires it will put in an up-to-date system.

MILWAUKEE, WIS.—The West Shore Telegraph & Telephone Company is seeking a franchise in this city.

CADOTT, WIS.—Mr. O. J. Jensen, owner of the exchange at this place, has 139 subscribers with 67 miles of toll line. Standard Telephone & Electric apparatus is used.

WASHINGTON, WIS.—The Loretto & Logansville Telephone Company, of Washington, Sauk County, capital stock $550, has been incorporated by R. C. Bremzer, Albert Prouty, Mike Flemming and seven others.

WALWORTH, WIS.—The Walworth Telephone Exchange Company began business in December, 1900, and operates a Kellogg switchboard of 100-drops capacity. The outlook is considered good for a fair increase.

WAUSAU, WIS.—The system of the Wausau Telephone Company is being changed to full metallic; a new board is being installed, and the office is being moved to the Heineman Block. The subscription list now numbers 600. An increase to 1000 is looked for.

EDGERTON, WIS.—If present plans mature, it is the intention of the Edgerton Telephone Company to occupy a building of its own and to install a new switchboard to take care of the growing business. Standard apparatus is used; there are 260 subscribers, with the prospect of 25 more this coming winter.

DURANGO, MEX.—Henry Lanvelt, who is said to represent a syndicate of Ohio capitalists, is investigating the situation here with the view of establishing a new telephone exchange here. He also proposes to build long distance telephone lines on the Pacific coast of Mexico.

OTTAWA, ONT.—Tests are being made of simultaneous telegraph and telephone service on the wires of the Canadian Pacific Railway between Ottawa and Montreal.

ELECTRIC LIGHT AND POWER.

BENTON HARBOR, ARK.—W. L. Cooper, Mayor, states that the city would grant an electric light franchise to responsible parties and assist them in the way of taking street lights, etc.

PETALUMA, CAL.—The California Central Company will construct here a 500-hp auxiliary steam plant.

BIGGS, CAL.—The election held here to incur an indebtedness of $12,000 for a municipal water system and electric light plant was carried.

SAN DIEGO, CAL.—Chas. E. Sumner, of Toledo, Ohio, and associates are interested in the construction of an electric light plant in San Diego.

SAN FRANCISCO, CAL.—The plant of the Independent Electric Light & Power Company has been turned over to the San Francisco Gas & Electric Company by Claus Spreckels, who took $5,000,000 worth of the other company's bonds as a part of the payment for his electric and gas plants. J. F. Lawless is now general manager of the San Francisco Gas & Electric Company. H. A. Woods, who has been superintendent of the independent electric power plant will remain in charge of that plant for some time and will hold a position with the purchasing company. The San Francisco Gas & Electric Company now owns all of the electric lighting plants of the city with the exception of those of the Mutual Electric Light Company and the Central Light & Power Company and has also a monopoly of gas lighting.

NEW HAVEN, CONN.—The Board of Aldermen has voted to award the contract for lighting the city streets for three years from Jan. 1, 1904, to the American Lighting Company, of Baltimore, Md.

ATLANTA, GA.—The Atlanta Water & Electric Company has borrowed $1,500,000, mortgaging all of its property to the Knickerbocker Trust Company, of New York, with which company the loan was negotiated.

MOLINE, ILL.—The People's Power Company has secured the contract for lighting the streets for five years at $65 per light per year for 210 lights or more.

DIXON, ILL.—The City Council has granted the Dixon Power & Lighting Company a contract to substitute for the present 85 gas lights in the city, 100 incandescent electric lights of 25-cp.

PANA, ILL.—At a special meeting of the City Council Nov. 24, the city arranged to have the city streets lighted. The city will pay $6 a month for each light. This is an increase of $1 a month over the old schedule.

SPRINGFIELD, ILL.—Don. E. Dietrich has been appointed receiver for the Chester Light, Water & Ice Company. The receiver was appointed on application for Union Trust Company, of New York, which holds the bonds of the concern.

CHICAGO, ILL.—Mayor Harrison has declared that the city will enter the electric lighting field at once in competition with the gas and electric companies. The attempt to enter the field by selling to corporations and private individuals electric current made in the municipal plants, it is expected, will result in an appeal to the courts by the big lighting corporations. This, Mayor Harrison declares, is what the city would invite, as it will determine its right to deal in public necessities.

HAMMOND, IND.—The Hammond Illuminating Company has changed its name to South Shore Gas & Electric Light Company.

COLUMBUS, IND.—Bids will be received by City Council Dec. 14 for the construction of an electric light plant, with a capacity of 125 lamps. The probable cost is placed at $10,000.

INDIANAPOLIS, IND.—Judge Anderson, of the Federal Court, has appointed the Indiana Trust Company receiver for the East Chicago Light & Power Company and the Lake County Light & Water Company. The receiver will take charge of and operate both plants.

DURANT, IND. TER.—It was voted Nov. 16 to issue $89,000 bonds for water works and an electric light plant.

OGDEN, IA.—The question of issuing bonds for a municipal lighting plant here will be voted on.

ALTOONA, IA.—It is reported that the Interurban Railway Company proposes to furnish electric light for this town.

GIRARD, KAN.—The state auditor has registered an issue of $20,000 bonds for an electric light plant.

AUGUSTA, KY.—Bids will be received Dec. 11 by W. C. Wittmeier, City Clerk, for an electric light franchise.

BORDEN, KY.—The Citizens' Electric Light Company has been organized at Borden with J. H. Durham, president; C. F. Stevenson, secretary, and C. E. Bierley, treasurer.

SEBAGO LAKE, ME.—The Sebago Lake Lighting Company has been organized at Portland to generate and distribute gas and electricity; capital, $10,000. D. D. Tripp is president; J. H. Rich, treasurer, both of Sebago Lake.

GRAND RAPIDS, MICH.—Edw. M. Deane & Co., of Grand Rapids, will expend about $50,000 in improvements. This company recently purchased the plant of the Citizens' Gas Light Company, of Grand Rapids, and the plant of the Vincennes Electric Light & Power Company, of Vincennes. W. B. Wales, of Grand Rapids, is engineer in charge.

LABELLE, MO.—The citizens on Nov. 21 voted to issue bonds for the purpose of installing an electric light plant.

LEXINGTON, NEB.—The City Clerk writes that the city is open to propositions for the construction of an electric light plant.

IRVINGTON, N. J.—The Committee on Public Lighting has been authorized by Council to inquire into the matter of municipal ownership of a public lighting plant.

HACKENSACK, N. J.—A fire which started shortly after midnight on Nov. 26, destroyed the lighting plant of the Hackensack Gas & Electric Light Company, on the Hackensack River. The damage will amount to more than $50,000. The building destroyed was about 40 feet wide and 120 feet long. It contained much valuable machinery, which was entirely destroyed. The station will be immediately rebuilt.

GENEVA, N. Y.—The Geneva Power & Light Company, of Geneva, has secured the contract of lighting the city for five years at $75 per year for 107 arc lamps, and $20 per year for 42 incandescent lamps.

OXFORD, OHIO.—The village council has decided to issue $3500 bonds for an electric light plant.

COLUMBUS, OHIO.—The board of public service is advertising for proposals on the material and work necessary to complete the municipal lighting plant.

TOLEDO, OHIO.—The old hydraulic canal at Perrysburg has been sold to St. Louis parties who will install a $150,000 plant for generating current for lighting and power.

MECHANICSBURG, OHIO.—T. J. Long, who owns an important water-power right at Mechanicsburg, has applied to the council for a franchise to erect a power plant and light the town.

ATHENS, OHIO.—The council has entered into a contract with the Erner-Hopkins Company, of Columbus, for the material and work in erecting a municipal lighting plant. A 250-hp engine and a 150-kw generator will be installed and current will be supplied for 80 arc lights and 2000 incandescent lamps. The contract price is $13,740.

CORAOPOLIS, PA.—Bids are wanted Dec. 7 for $20,000 water works and electric light extension bonds.

GLEN CAMPBELL, PA.—A charter has been granted to the Giant Electric Light, Heat & Power Company, of Glen Campbell, with a capital of $10,000.

JEFFERSON, TENN.—G. A. Moody has petitioned for a franchise for an electric light plant.

COLUMBUS, TEX.—John A. Cook and Sealy B. Moody, of Lagrange, Ill., have in contemplation the construction of an electric power plant near Columbus.

SALT LAKE CITY, UTAH.—Meetings of stockholders of the Utah Light & Power Company and the Consolidated Railway Company will be held here on Dec. 15, with a view to effecting a consolidation of the two companies and the expectation is that the union will be consummated by the first of next year. Improvements will be provided for to the extent of from $200,000 to $300,000 annually for a number of years. It is expected that no money will change hands in the deal, which is to be made for the mutual interest of both companies. The new company will merely exchange stock for certificates of the older companies on an agreed basis.

WENATCHEE, WASH.—The Lamb-Davis Lumber Company has secured a franchise for water works and an electric light plant.

CONCONULLY, WASH.—The Pinnacle Mining Company is making extensive improvements here, and among other things will erect a power plant about 1½ miles from the mine. The power will be derived from the falls on Toat's Coulee Creek.

NEENAH, WIS.—John I. Beggs, president of the Milwaukee Electric Railway & Light Company, representing a Milwaukee syndicate, is about to ask for a franchise to light this city.

BLACK RIVER FALLS, WIS.—Mayor Bright, on behalf of the city, has taken option on the water power, power house and several buildings for $25,000. The object is to have the city control the power so that it can run its own electric light plant and water pumping station.

SANTA FE, N. M.—The Capital Light & Power Company is a recently organized corporation which will build a large electric power plant near this city. Mr. A. R. Gibson, of this city, is the promoter of the enterprise. Work has already been commenced on the plant and contracts let for lines which will be strung to Las Vegas, Albuquerque and other points to convey electrical power. The power for the plant will be generated from the waters of the Pecos river.

OTTAWA, ONT.—Regarding the oft-reiterated stories of the fear that the natural features of Niagara Falls will be destroyed by the commercial demands at that locality, Mr. J. W. Langmuir, of the Canadian Park Commission, says there is no occasion for such alarm so far as the Canadian government is concerned. He says: "The artistic value of the Falls, I believe, has been improved by the work done in conformity with the concessions granted by the commission on this side. Eighty-five per cent of the total water fall passes over the Canadian side. This gives us ample control of the situation. We have granted concessions approximating 400,000 horse power. The full supply of water may not be utilized for a century." The volume of water passing over the Canadian Falls cannot be diminished to any appreciable extent by the commercial concessions now granted. On the other hand Mr. Langmuir thinks there is danger of all the water now passing over the American Falls being diverted when the concessions there are fully utilized.

OTTAWA, ONT.—The Ontario Legislature, at its last session, passed an act empowering a commission of five persons to enquire into and report upon a scheme for vast power supply to a group of Ontario municipalities. The commission is encountering some difficulty in securing the services of a competent expert electrician to act as the fifth member of that body. It will cost $10,000 to secure a preliminary report alone on the power question, to enable the municipalities to work out the problem before them. Some 50,000 horse power, it is estimated, will be utilized immediately by 20 towns and cities which have already manifested a disposition to participate in the power scheme. At least half of this power will be used in Toronto, and the balance will be distributed over western Ontario. It is stated that the plant for generating and distributing the power could be ready in three years. The commission figures on 50,000 horse power for immediate use only, but that amount does not comprehend the enormous development, industrially, that will cover the Ontario peninsular when the practicability of the plan has once been demonstrated. The power will be drawn from Niagara Falls. It is calculated that a horse power, now costing $40 to develop, can be secured by the scheme proposed for not more than $15.

THE ELECTRIC RAILWAY.

BIRMINGHAM, ALA.—The Birmingham Railway, Light & Power Company has let the contract for an addition to the power house, which will cost with equipment over $200,000, thus adding 5000-hp to the present capacity of 9000-hp. The new engines alone will cost $56,000 and will be furnished by the Brimingham Machine & Foundry Company.

ATLANTA, GA.—A mortgage has been filed by the proposed Atlanta and Marietta Electric Railway Company to the Guaranty Trust Company, of New York, to secure a bond issue of $600,000 to cover the cost of the projected electric railway between the places named.

DIXON, ILL.—The contract for building the Dixon, Rock Falls & Southwestern Railway has been awarded to Maffee, Carter & Company, of New York City. The plan of the company is to build an electric railway from Dixon to Rock Falls.

CHICAGO, ILL.—The Blue Island, Riverdale & Hammond Street Railway Company has been incorporated; capital stock, $50,000. Incorporators and first board of directors: Wm. R. Owen, August W. Miller, John F. Noel, Henry Schanze and Michael J. Corcoran, all of Chicago, Ill.

CHICAGO, ILL.—The strike of the employees of the Chicago City Railway Company, which began on Nov. 12, was ended on Nov. 25. The 1500 members of Division 260 of the Amalgamated Association of Street and Electric Railway Employees of America voted to accept an agreement made with the officials of the Company in the Mayor's office, and they returned to work on Thanksgiving Day, Nov. 26. The substance of the agreement is as follows:. Wages, company and men agree to arbitrate; present scale to be set aside and the actual worth of labor to be estimated without regard to wages paid at present. This may raise some wages and lower others. Routing of Cars—Two propositions made; men may take choice. One is a minimum of eight hours and a maximum of eleven, all within the limit of fifteen hours. The other alternative is an opportunity to earn ten hours' pay in fifteen hours. Closed shop—Company retains the right to discharge, discipline and hire its men without interference of the union in any way. Shop to be open to union and non-union men alike. Employment—Company will take back all of its striking employees except those who have been found guilty of violence since Nov. 1. This includes those who went on sympathetic strikes.

RICHMOND, IND.—C. N. Wilson, of the Columbia, Greensburg & Richmond Traction line, has asked the County Commissioners for a franchise through the county. The line will follow the Centerville route from Connersville to Richmond.

RICHMOND, IND.—It is semi-officially announced that the Indianapolis & Eastern Traction Company will ask the Commissioners of Wayne County for a franchise from Dublin to Richmond, that it may have its own line from Indianapolis to Richmond.

ANDERSON, IND.—The City Council has granted a franchise to Wallace B. Campbell for an electric railway from Anderson to Lebanon. He states that he now has a franchise from all the towns and cities through which the line passes and much of the roadbed right of way.

ATTICA, IND.—An election has been ordered in Logan Township, Warren County, for the people to vote on the question of a 2 per cent subsidy for the Tipton, Frankfort & Attica Traction Company. The election will be held Dec. 8. The subsidy will probably be voted, as there is a great desire for the road.

CORYDON, IND.—The County Commissioners have granted to the Leavenworth Electric Railway a franchise through Harrison County. The company will build a line from New Albany to White Sulphur Well via Leavenworth. T. B. Elsworth is president of the company, and S. A. Beales, secretary. Both are residents of Leavenworth.

DAVENPORT, IA.—John U. May, who has been promoting an electric railway between Davenport and Clinton, has sold all his franchises and material to the Iowa & Illinois Railway Company, which is now at work constructing an electric railway between the two points. The latter company is promoted by Thomas Wilcox, of Des Moines.

TOPEKA, KAN.—A charter has been granted to the Topeka, Eskridge & Council Grove Interurban Electric Railway Company by the State charter board. The company is capitalized at $50,000, and is a local concern organized by merchants, business men and farmers along the route.

ARKANSAS CITY, KAN.—The City Council has granted to L. P. P. Northrup, of Arkansas City, and others, a franchise for the purpose of building an electric railway, light and power plant. Besides building in the city, the company will build an interurban road with Arkansas City as a center. It is the intention of the company to connect Winfield and Arkansas City and the Chilocco Indian School. St. Louis capital is said to be behind the enterprise.

LOUISVILLE, KY.—The Board of County Commissioners of Floyd County, Indiana, at New Albany, has ordered an election to be held Dec. 10 to determine whether or not the townships of New Albany and Franklin shall vote a subsidy of 2 per cent for the aid of the Louisville & Southern Indiana Traction Company in New Albany and Franklin Townships. Should the subsidy be voted, $206,000 will be realized from New Albany Township, and about $10,000 from Franklin Township. The money is to be used in constructing an electric railway from New Albany to Corydon.

BALTIMORE, MD.—It is said that at the coming session of the Legislature it is proposed to pass a "Jim Crow" law like that in Virginia, providing separate street cars, as well as separate compartments, for negroes in steamboats and on railroad trains running through Maryland.

AUGUSTA, ME.—Articles of association have been filed for the Lewiston & Kennebec Street Railway, to run from Lewiston, through Webster, Wales, Monmouth, Litchfield, West Gardiner to Gardiner, 21 miles. The incorporators are Sidney M. Bird and Maynard S. Bird, of Rockland; George W. Heselton, of Gardiner; John D. Clifford and Charles C. Benson, of Lewiston, and Edward W. Gross, of Auburn.

DETROIT, MICH.—The Detroit, Flint & Saginaw Railway Company has been organized, with T. E. Tarnsey, president; John A. Russell, vice-president and general manager; A. S. Nester, secretary, and Thos. G Sullivan, treasurer. The company will shortly incorporate, with $1,000,000 capital. Orders are said to have been placed for 13 miles of track.

CAMDEN, N. J.—The temporary obstacles placed in the way of the Camden & Suburban Railway Company from continuing its route to Trenton have been removed, and the line will probably be open for travel by Dec. 1.

JERSEY CITY, N. J.—The Interurban Traction Company, with a capital of $1,000,000, has been incorporated here by Frank Cook and R. W. G. Welling, of New York, and R. F. Tully, of Jersey City. The object of the company is to operate electric and steam railways.

NEWARK, N. J.—The Public Service Corporation of New Jersey has leased the Orange & Passaic Valley Street Railway Company for 900 years. According to the lease, the Public Service Corporation will pay to the lessor $3,000 on May 1, 1904, and the same amount every six months thereafter until Nov. 1, 1905. This amount will be increased yearly until 1913, when $18,000 will be paid and continued annually thereafter.

BROOKLYN, N. Y.—Tests are about to be made by the Brooklyn Rapid Transit Company in the carrying away of ashes and street sweepings of this borough by cars on the company's lines. The arrangement provides for 13 stations where the ashes and sweepings will be loaded on the cars. All this work will be done at night, and the refuse will be placed in large zinc buckets and carried to the swamp lands on Coney Island owned by the Brooklyn Rapid Transit Company.

WAPAKONETA, OHIO.—A reorganization of the Sandusky Southwestern Electric Railway was effected at the annual meeting when four of the officers and six directors were deposed. Officers were elected as follows: John Van Fleet, president; F. O. Oleson, vice-president and general manager; G. A. Smith, secretary, and Lyman Means, treasurer. The company has recently made a $2,000,000 bond issue, and the prospects for completing the road look very bright. Construction work has been started again.

YORK, PA.—Negotiations have been concluded between the York County Traction Company and the Wrightsville Turnpike Company by which the former will build its line between York and Wrightsville on the turnpike.

BEAVER, PA.—In order to obtain money with which to extend its lines to meet the West End line at Coraopolis and the New Castle Electric Railway at Mahoningtown, the Beaver Valley Traction Company has mortgaged its 15 miles of electric railway in the Beaver Valley to the Northern Trust Company, of Philadelphia, in the sum of $3,000,000. It is stated that the New Castle Traction Company will build from Mahoningtown to Wampum, a distance of 4 miles, to meet the Beaver Valley line. These extensions will make direct street railway communication between Pittsburg, New Castle, Youngstown, Warren, South Sharon, Sharon, Sharpsville and Beaver.

NASHVILLE, TENN.—The Nashville & Gallatin Interurban Railway Company has sold its property to the Nashville & Columbia Interurban Railway Company for $100,000. The deal was accomplished by the purchase by Thomas E. Perry, Jr., and H. A. Gross, of Pittsburg, of the interests of C. W. Ruth and Frank Haskell. The name adopted was the Nashville, Columbia & Gallatin Electric Railway Company. This company decided to retain the charter granted to the original companies, and to file amendments to these authorizing it to increase its capital stock from $100,000 to $3,000,000. Officers were elected as follows: Thomas E. Perry, Jr., president; H. M. Gross, vice-president, secretary and treasurer; E. J. Kent, chief counsel, and J. H. Connor, general manager.

BROWNSVILLE, TEX.—It is stated that a street railway system is to be built here. Lon Hill can give information.

SAN ANTONIO, TEX.—The strike of the employees of the San Antonio Traction Company is practically ended. A number of the strikers have applied for their old positions and have been taken back by the company. No concessions were granted the strikers by the company.

SALT LAKE CITY, UTAH.—Articles of incorporation have been filed by a local company to construct an electric railway from Ogden to Brigham City, a distance of 20 miles. The company has a capitalization of $200,000 and the officers are Thomas D. Dee, of Ogden, president; Hiram H. Spencer, vice-president, and Charles H. Kircher, secretary.

YORKTOWN, VA.—The Newport News & Old Point Railway & Electric Company has under consideration a plan to connect Yorktown with Newport News by an extension of its lines.

PARKERSBURG, VA.—The stockholders of the Parkersburg & Ohio Valley Street Railway Company are said to have made completed arrangements for financing their project. A construction company has been partially organized and a charter applied for.

VANCOUVER, B. C.—It is said here that the Seattle-Tacoma Electric Railway Company, which operates between Seattle and Tacoma, has decided to extend its line into Vancouver next year. The Great Northern Railroad, it is said, is trying to secure control of the Westminster Bridge so as to keep the tramway company from passing over the bridge, as the proposed electric line will compete with the Northern Company's road.

WINNIPEG, MAN.—Montreal and Toronto capitalists are about to form a company and apply for a charter to build an electric railway from Winnipeg to Brandon. The road will be for both passenger and freight traffic.

GUADALAJARA, MEX.—Charles Carroll and Charles Kratz, of St. Louis, Mo., have been granted a concession to build and operate an interurban electric railway from this city to Ranch Barranca, a distance of 54 kilometers.

MONTREAL, QUE.—The City Council has voted not to grant a thirty years' extension of the franchise of the Montreal Street Railway Company.

NEW INDUSTRIAL COMPANIES.

THE TOLEDO AUTOMATIC FENDER COMPANY, capital $10,000, has been incorporated by Frank F. Gentsch and others.

THE ROCKWOOD ELECTRIC COMPANY, of Rockwood, Somerset County, Pa., has been incorporated with a capital of $20,000.

THE STERLING ELECTRIC COMPANY, Troy, N. Y., has been incorporated; capital, $50,000. Directors: J. K. P. Pine, J. J. Child and H. E. Northrup, Troy.

THE SELF-ILLUMINATING SIGN COMPANY, New York, has been incorporated; capital, $10,000. Directors: C. M. Becker, C. F. Davis and T. M. Clancy, New York.

THE INSTANTANEOUS NEWS COMPANY, New York, has been incorporated; capital, $50,000. Directors: J. J. Dooley, F. C. Barnes and A. N. Webster, New York.

THE FORD AUTOMOBILE COMPANY has been incorporated at St. Louis, Mo., by Jordan W. Lambert, Lewis Spindle and Samuel B. McPheeters. The capital stock is $2000.

THE CONTINUOUS TRANSIT SECURITIES COMPANY has been incorporated to equip railways and moving platforms; capital, $500,000. Directors: A. P. Cobb, D. L. Gallup, H. A. Stickney, New York.

THE INTERNATIONAL ELECTRIC METER COMPANY, of Chicago, has been incorporated; capital, $10,000, to manufacture electrical specialties. Incorporators: W. W. Cheney, Jr., Samuel Solomon, O. C. Peterson.

THE ELECTRO DYNAMIC COMPANY has been incorporated at Bayonne, N. J., to manufacture electric motors; capital, $50,000. Incorporators: Augustus Treadwell, Burgess S. Cruden and Edward P. Kingsland.

THE COLUMBIA POWER COMPANY, of Minneapolis, has filed articles of incorporation for the purpose of constructing electric motors and engines. The incorporators are William S. Herber, S. Edward Woodbury and Fred W. Bates.

THE ELECTRIC BLOCK SIGNAL SEMAPHORE COMPANY has filed articles of incorporation in Jersey City, N. J. The capital stock is fixed at $250,000, all paid up. The incorporators are Henry M. Protest and Mortimer M. Kinsey.

THE TYRON ELECTRIC SUBWAY COMPANY, with principal office at Gloversville, N. Y., has been incorporated to maintain subways; capital, $10,000. Incorporators: John Martin and George Green, Gloversville, N. Y., and J. G. Edwards, Glen, N. Y.

THE STARK TELEPHONE, LIGHT & POWER SYSTEM, manufacturer of electrical appliances, has been incorporated at Toronto, Ont. Capital, $1,000,000. Provisional directors: A. M. Stark, Gideon Grant, Edward Kilner, J. C. Gardner, Andrew Dods, Jr.

THE SUPERIOR ELECTRICAL & MANUFACTURING COMPANY, Jersey City, N. J., has been incorporated to manufacture electrical apparatus; capital, $100,000. Incorporators: Worthington H. Ingersoll, Hamburg, N. J.; Frank J. Higgins, Wm. F. Midlige, Jersey City, N. J.

THE NATIONAL TELEPHONE LOCK COMPANY has been formed at Washington, D. C., for the purpose of manufacturing and selling coin-operating telephone locks. The incorporators are R. K. Van Mater, W. C. Dashiell, L. A. White and C. L. Bradford, and the capital stock is $250,000.

THE MONARCH ELECTRIC MANUFACTURING COMPANY, capital stock $10,000, has been incorporated at Warren, Ohio, by J. F. Kistler, Wm. Michael, J. W. Slater, C. H. Sager, Frank Myers, S. J. Parks and G. C. Reeves. The company will manufacture incandescent lamps. The board of trade of Niles, Ohio, has submitted a proposition to the promoters to locate the factory in that town. Under certain conditions the town offers to furnish a factory rent free, to be deeded to the company after a term of years.

LEGAL.

ATMOSPHERIC ELECTRIC TROUBLES.—In a recent suit against the Phœnix Light & Fuel Company appealed to the Supreme Court of Arizona, the court held that a company furnishing electric power is not guilty of negligence because in carrying its wires into a building it fails to insulate against electricity having its origin in the clouds or atmosphere.

INTERFERENCE IN STRIKE.—In the City of Waterbury eight young men have been sent to jail to serve ten months' sentences for participation in the riots attending the street-car strike disturbances. These young men were not on strike and had no interest in the issues raised between the company and its employees. The riots in which they participated were of a most violent and destructive character.

TELEPHONE FRANCHISE.—In an appeal to the Court of Appeals of Kentucky, in the suit of Maraman vs. Ohio Telephone Company, the point up related to the Ky. St. 1899, § 3699, providing that no ordinance or resolution shall be passed by cities of the sixth class, granting any franchise, until five days shall have elapsed after its introduction, nor at any other than a regular meeting of the board of trustees. It was held by the review court that where an ordinance authorizing the advertisement and sale of an exclusive telephone franchise, and another ordinance ratifying a sale to plaintiff had under the first ordinance, were both passed at the same meeting at which they were introduced, the franchise so granted was void.

INJURY FROM TELEPHONE WIRE.—In an appeal by the Cumberland Tel. & Tel. Company to the Court of Appeals of Kentucky, the decision in favor of plaintiff's administrators was reversed. Deceased took refuge from an electric storm under the porch of a store. He placed his back against an iron grating over a window and was subsequently killed by lightning which struck one of defendant's telephone poles near the store and was conducted to the porch by a wire negligently maintained over the metal roof thereof, and from the roof to the iron grating, and thence to deceased. It was held on appeal that deceased was a bare licensee in the place where he was killed, and that defendant owed him no duty to properly maintain the wire.

CONTROL OF ELECTRIC POWER.—The Supreme Court of New York State in the action between the Hudson River Power Company and the Glens Falls Portland Cement Company had to consider the question of an assignment of right to use power. The power company contracted to supply the cement company with electric energy for five years on monthly payments, the energy to be used in and upon the premises of the cement company. Thereafter the cement company assigned such contract to a lighting company, without the consent of the power company; the lighting company intending to use such energy on its premises and in its business generally, in a manner that would bring it in competition with the power company. It was held that such assignment without the consent of the power company did not give the lighting company the right to use the current in its business, nor entitle it to compel specific performance by the power company.

REMOVAL OF TELEPHONE POLES.—The city of Bradford, Pa., filed a bill to compel the New York & Pennsylvania Telegraph & Telephone Company to remove its poles and wires from the streets which it had occupied for more than 21 years without objection, after an expenditure of about $100,000. Many resolutions of the city council had given permission for the erection and use of the poles and cross-arms on the streets. In consideration of the privileges, the city had obtained a right to the use of the poles for the carrying of the fire alarm system, and had also levied licenses and pole taxes, and had used telephones furnished by the company down to the date of the hearing, and had regulated by ordinance the manner in which the poles should be erected under the direction of the street committee of council or the city engineer. The lower court having dismissed the bill, the Supreme Court of Pennsylvania on appeal by the plaintiff city held that the bill was properly dismissed for laches.

OBITUARY.

MR. O. S. WILEY.—We regret to note the death of Osgood S. Wiley, Nov. 30, at Orange, N. J., after a brief illness, aged 48 years. Mr. Wiley was an electrical engineer. He was also at one time manager of the Orange district of the New York & New Jersey Telephone Company. He had been in poor health for over a year, but it was only recently that his ailment had taken a dangerous turn. Mr. Wiley is survived by a widow and three sons.

EDUCATIONAL.

UNION COLLEGE AT ST. LOUIS FAIR.—The directors of the School of Electrical Engineering at Union College, Schenectady, N. Y., are considering the advisability of having an exhibit at the St. Louis Exposition, and the probabilities are that such an exhibit will be made.

PERSONAL.

MR. N. C. MARSHALL, of Vancouver, B. C., has been appointed western manager of the Marconi Wireless Telegraph Company.

MR. GANO S. DUNN, chief engineer of the Crocker-Wheeler Company, of Ampere, N. J., has just returned home from a trip across the Atlantic.

MR. W. H. HARVEY, consulting engineer, Memphis, Tenn., is preparing plans and specifications for a $20,000 light and water plant which Belzona City, Miss., is to install.

MR. C. A. MOORE, of Manning, Maxwell & Moore, returned to New York last week on the *Cedric*, whose reported loss at sea caused a temporary anxiety for his welfare among hosts of friends.

MR. W. A. LOMOFF, of St. Petersburg, who is connected with the Westinghouse interests in Russia, is now on a visit to this side. At present he is at the East Pittsburg plants of the Westinghouse people.

MR. J. H. TRUMBULL, general manager and treasurer of the Trumbull Electric Manufacturing Company, of Plainville, Conn., was married, Nov. 28, to Miss Maud P. Usher. They have gone to Washington to spend their honeymoon.

MR. R. PERCY SELLON, who has been spending a fortnight in this country on business connected with large contracts for Otis elevators which he represents in the English directorate, sailed for home last Saturday apparently very well pleased with the results of his trip.

MR. F. NEUGEBAUER, for several years resident manager of the Siemens & Halske Company in Mexico City, whose plant has been taken over by the Mexican Light & Power Company, Limited, has been appointed resident manager for the latter concern in the Mexican capital.

MR. J. B. ALLEN.—The board of directors of the Allis-Chalmers Company, at a recent meeting, elected John B. Allen, of Chicago, a vice-president and general manager of the company, making him the active and responsible manager in charge of manufacturing, selling and general operations.

JUDGE J. M. THOMAS, past president of the Independent Telephone Association of America, and long a leader in the independent telephone movement, has, we regret to state, been quite ill lately, having been confined to his bed for the past two weeks under the doctor's care. He is now convalescent and expects soon to resume his professional duties.

SMITH-COFFIN.—Mr. Jesse M. Smith, the well-known consulting mechanical and electrical engineer was married at Nantucket, Mass., on Thanksgiving Day, Nov. 26, to Miss Annie Coffin, daughter of Mrs. Charles Henry Coffin. Mr. and Mrs. Smith will reside in New York City where Mr. Smith is now practicing his profession.

MR. F. S. PEARSON, vice-president and general manager of the Mexican Light & Power Company, Limited, has just returned to New York from a trip to Mexico, whither he went recently to inspect the progress made in the construction of the huge Necaxa plant which is to generate power for transmission to Mexico City and the El Oro mining district.

MR. A. N. CONNETT, C. E., who is now associated with the London electrical engineering and contracting firm of J. G. White & Company, has been in this country on a brief visit home and to see his son, who is at the Rennselaer Polytechnic Institute. Mr. Connett sailed this week for England, where he now feels very much at home and where he has been engaged on some very important traction contracts.

MR. G. MARCONI.—An article in the *London Times* makes note of the successful experiments of Mr. Marconi for the British Admiralty and navy during October and November between Gibraltar and Poldhu, as well as between the latter station and the battleship *Duncan,* in the Bay of Biscay. Some very good results were obtained although the Rock and the whole of Spain intervened between the two signalling points.

DR. HANS GOLDSCHMIDT, of Essen-Ruhr, Germany, will read a paper on his invention in alumino-thermics and its application to metallurgy and engineering before the members of the American Society of Mechanical Engineers at the Stevens Institute at Hoboken on Dec. 3, at 3 p. m. A number of experiments will be made, including the welding of a girder rail and of a tube. Details of this work have already been given in our columns.

MR. CARL HERING has been nominated on the official ballot of the Engineers' Club of Philadelphia for the presidency of the Club. A book of electrical data compiled by Mr. Hering will soon issue from the press, which work should be of great value from the author's exceptional acquaintance with the periodical electrical literature of the past ten years, during which period and until recently he conducted the Digest of this journal.

MOREHOUSE & MORRILL have established themselves as electrical engineers and contractors in the Crossley Building, San Francisco. The firm comprises Herbert H. Morehouse and Grant A. Morrill. They have had an experience of some twelve years in Central America in installing and managing long and short distance transmission plants for light and power, and have developed several hydraulic properties. They have also installed and operated some telephone systems.

MR. JOHN I. BEGGS, of Milwaukee, who has been elected general manager of the Union Electric Light & Power Company, of St. Louis, is president and general manager of the Milwaukee Electric Railway & Lighting Company. Mr. Beggs will divide his time between Milwaukee and St. Louis. He contemplates inaugurating many new methods in the management of the Union Electric Light & Power Company, and the building of a new power plant is being done under his personal supervision.

ZANGWILL-AYRTON.—The marriage took place in London, on Nov. 26, of Mr. Israel Zangwill, the distinguished dramatist, novelist, and "Zionist," to Miss Edith Ayrton, daughter of Prof. W. E. Ayrton, F.R.S., the well-known electrical engineer and technical educator. Miss Ayrton, who is an authoress of some note, has a large American circle of friends, and visited this country with her father some years ago, when they were entertained by Mr. Nikola Tesla and others. It is hoped that she and her husband may soon revisit these shores. The wedding in London was attended by a number of prominent people in the social, artistic and literary worlds.

MR. CHARLES CHURCHILL, managing director of Charles Churchill & Company, Limited, of London, Manchester, Birmingham, Newcastle-on-Tyne and Glasgow, which concern represents the British interests of more than 100 American manufacturers of machine tools, etc., sailed for Europe on the Cunarder *Lucania,* Nov. 28, after a visit of seven weeks' duration on this side. On the eve of sailing Mr. Churchill received a cable from the London office stating that the outlook for business was very encouraging. Mr. Charles Churchill, Jr., will come over in the early spring and manufacturers on this side can look forward to securing some good orders then. Mr. Churchill expects to pay this country another visit next fall.

MR. C. N. DUFFY, who for some months past has held the position created for him of Comptroller of the Interurban Street Railway Company, of New York City, has returned to Chicago and resumed his former position of auditor of the Chicago City Railway, which owing to the complications in its affairs and its relationships with the city found his skill and experience absolutely indispensable at this juncture, and insisted upon recalling him. Mr. Duffy has been doing splendid work in New York, and President Vreeland was most reluctant to let him go, but the results already accomplished by Mr. Duffy rendered his retirement less serious than it would otherwise have been. Mr. Duffy's departure is viewed with deep regret by a host of New York friends.

MR. PAUL HUDSON, publisher and managing director of the *Mexican Herald,* the English financial and leading newspaper in Mexico City Republic left for home last week after several weeks' visit to this country, making a quasi government and administrative investigation of the recent electric power, lighting and traction projects which are being subsidized and encouraged financially by President Porfirio Diaz and the Mexican Government, including the great power and lighting plant of the Guanajuato Company in which John Hayes Hammond is largely interested. While here Mr. Hudson had occasion to bring before prominent New York capitalists several important projects for developing electrical possibilities for power in the mining regions which are so plentiful in the mountains of Mexico.

Trade Notes.

CENTURY ELECTRIC COMPANY.—The H. E. Lindsey Electrical Supply Company, of St. Louis, Mo., has just changed its name to the Century Electric Company.

JEFFREY MFG. COMPANY, Columbus, Ohio, has issued a handsome catalogue, No. 52, devoted to its Jeffrey coal washing machinery, illustrating and describing it in detail. The catalogue contains also data with regard to its other appliances and apparatus, including that of an electrical character.

SUPPLIES WANTED.—Mr. Cyrus Laurence, 1501 Franklin Street, Campbello Addition, Jacksonville, Fla., has requested catalogues and price-lists relating to line cutouts, porcelain insulators, wood cleats, porcelain cleats, cleat covers, single and double pole knife switches, lamp sockets, plugs, fuses and incandescent lamps.

THE CENTRAL ELECTRIC COMPANY, Chicago, reports an exceptionally good business on Nernst lamps and Westinghouse wattmeters during the past few weeks. The company is carrying a large complete assortment of both of these lines in Chicago stock, and is therefore in a position to assure its customers of prompt shipment.

NORTHERN ELECTRICAL MFG. COMPANY, of Madison, Wis., has brought out a new motor booklet devoted to its B frames, a new size built to meet the demand for a Northern motor smaller than those heretofore manufactured by it. The pamphlet describes in detail the standard features of the apparatus. These motors are practically miniature representations of the company's standard spherical motors.

FORCED DRAFT.—The Buffalo Forge Company, Buffalo, N. Y., has issued a handsome little pamphlet on the subject of its forced draft apparatus. The advantages and availibility of forced draft are comprehensively discussed, and there are several views of plants installed with the Buffalo forced draft apparatus. Other illustrations show the various styles of fans used in this work, Buffalo engines, etc. Another pamphlet issued by the company is devoted to an equally clear description of its steel pressure blowers. It is also completely illustrated.

MR. W. F. WARNER, of Muncie, Ind., has issued a little circular showing three illustrations of his arc lamp for series circuits. These illustrations show the lamp for indoor and outdoor use, and the working parts of the lamp with the casings removed. In his circular Mr. Warner speaks of his long experience in the electric lighting field and the need for enclosed arc lamps for high tension circuits. Mr. Warner made the lamp primarily for his own use and finding how successfully it worked he is manufacturing it for circuits where generators are the old 9.6-amp. machines.

THE VIADUCT MFG. COMPANY, of Baltimore, is calling attention to the new Skirrow telegraph switchboard. This new type of board is designed to provide a switchboard for intermediate offices, and is so arranged that every switch or connection that could possibly be required might be made by anyone of ordinary intelligence and without any electrical knowledge whatever. It is so constructed as to be practically fireproof, possessing high insulation. The Viaduct Company is making specially good telephones of the latest design, and a line of district messenger boxes and fire alarm boxes.

COPPER TERMINALS.—Mr. Charles D. Shain, of New York City, well and long known in the electrical field, has returned to it again and is now introducing new copper terminals. He says that these were originally designed to meet a great want in the automobile field, and the concern has been extremely successful in meeting that want, so that these terminals are now in use in nearly all prominent machines. It has found a demand for these terminals in the electrical field and many of the large electrical supply houses are carrying them in stock. Mr. Shain will be glad to receive and answer inquiries in regard to this excellent specialty.

THE GREEN BOOK OF HARDWARE.—The well-known hardware specialty house, Smith & Hemenway Company and Utica Drop Forge & Tool Company, of 296 Broadway, New York, publisher of the Green Book of Hardware Specialties—a catalogue so well-known that little more need be written of it—has subdivided this book into four sections, uniquely and attractively printed on a green French folio paper. These sections, "Glaziers," "Electrical," "Razor," and "Caster" were printed in compliance with the request of many customers, to get up a catalogue small enough to be conveniently carried in the pocket. This progressive firm is ever on the alert for an attractive catchiness in its advertising, and in these subdivisions of the Green Book has got out something that is not only attractive but useful, and the light paper on which they are printed makes them fit so snugly in the pocket that they are always carried, and constantly used for reference.

FACTORY EQUIPMENT.—The second edition of catalogue No. 115, the condensed general catalogue of the B. F. Sturtevant Company, Jamaica Plain, Mass., has gone to press and will very soon be ready for distribution. A few pages in this revised edition have been devoted to factory and industrial railway equipments, a new departure of this enterprising concern. The outgrowth of the success attained in equipping their new plant at Hyde Park, Mass., was the manufacture of this new line of products. Work is fast nearing completion upon the new power plant of the company at Hyde Park. This bids fair to be one of the most complete plants of its kind in the country, special care having been taken in connection with every detail to secure the highest efficiency and the most modern equipment. The plant will comprise four water tube boilers, with stokers supplied by Sturtevant forced draft, an economizer with Sturtevant induced draft, and a complete outfit of Sturtevant generating sets, together with condenser, air compressor, etc. The Sturtevant exhaust head is used for separating the water and oil from the exhaust steam.

Record of Electrical Patents.

UNITED STATES PATENTS ISSUED NOVEMBER 24, 1903.

[Conducted by Wm. A. Rosenbaum, Patent Attorney, 140 Nassau St., N. Y.]

744,706. BLOCK SIGNALLING SYSTEM AND APPARATUS THEREFOR; James E. Allison, St. Louis, Mo. App. filed Aug. 30, 1902. Details of an electric automatic system.

744,707. STATIC ELECTRICAL MACHINE; Thomas Archer, Woodside, N. Y. App. filed June 23, 1903. The openings at the center of the glass disk have polished solid edges to prevent breaking.

744,716. SIGNAL FOR RAILWAYS; Willis C. Bryant, Elizabeth, N. J. App. filed Mar. 1, 1902. Details of a system especially adapted for tunnels, the signals being placed on the locomotive.

744,726. SHARPENER FOR EDGED TOOLS; Theron Davis, New York, N. Y. App. filed Sept. 24, 1902. (See Current News and Notes.)

744,735. TELEPHONE EXCHANGE; Charles S. Exley, Clarke County, Ia. App. filed Aug. 20, 1902. (See page 926.)

744,736. ELECTRIC SWITCH; Charles E. Felt, Pullman, Ill. App. filed April 21, 1902. A push switch in which the motions on opening and closing are quick, regardless of how rapidly the button is pushed.

744,739. ELECTRICALLY-HEATED HANDLE; Robert A. Fliess, East Orange, N. J. App. filed Jan. 29, 1902. (See Current News and Notes.)

744,758. POCKET BATTERY; Wilhelm Heyn, Berlin, Germany. App. filed Aug. 15, 1903. (See page 923.)

744,770. TROLLEY; Levi L. Leathers, St. Albans, Me. App. filed April 22, 1903. Guard arms rising above the wheel are allowed to yield when a cross wire is encountered and afterwards returned to their normal position.

744,773. ELECTROMAGNET; David L. Lindquist, Yonkers, N. Y. App. filed July 14, 1903. An electro-magnet having a number of coils symmetrically disposed around a central axis, the individual axis of each coil being parallel to the central axis; the magnet is used with alternating currents.

744,817. PROTECTED SWITCH MECHANISM; August Sundh, Yonkers, N. Y. App. filed July 14, 1903. The switch lever is in a box having a flexible side, which is moved externally to actuate the lever.

744,818. ELECTRIC CONTROLLER; August Sundh, Yonkers, N. Y. App. filed Aug. 5, 1903. An electrically controlled circuit closer, a device for mechanically preventing the movement thereof to close the circuit, and electromagnetically controlled devices for actuating said device to permit the circuit closer to operate.

744,829. RAIL JOINT; George A. Weber, New York, N. Y. App. filed March 18, 1903. This patent and those following in the same name, cover the details of construction of an insulated rail joint, involving a peculiar arrangement of chairs, fish-plates and insulation.

744,832. INSULATED RAIL JOINT; George A. Weber, New York, N. Y. App. filed April 15, 1903. See preceding patent.

744,834. INSULATED JOINT; George A. Weber, New York, N. Y. App. filed April 15, 1903. See patent No. 744,829.

744,835. RAIL JOINT; George A. Weber, New York, N. Y. App. filed April 17, 1903. See patent No. 744,829.

744,849. FIRE-ALARM SYSTEM; Albert J. Woodworth, Sparrows Point, Md. App. filed July 3, 1902. (See Current News and Notes.)

744,895. STORAGE BATTERY PLATE; Joseph Bijur, New York, N. Y. App. filed Aug. 14, 1900. (See page 923.)

744,897. MEANS FOR DIRECTING ELECTRIC WAVES FOR USE IN WIRELESS TELEGRAPHY; Ferdinand Braun, Strassburg, Germany. App. filed Feb. 19, 1902. (See page 919.)

744,904. MAIL BOX ATTACHMENT; John R. Clark, Dahlgren, Ill. App. filed April 15, 1903. The dropping of mail in the box actuates an electrical indicator or alarm.

744,911. ELECTRIC LIGHT SWITCH; Ernest L. Etheridge, Brooklyn, N. Y. App. filed Oct. 9, 1902. A switch adapted for cutting a lamp into or out of circuit, the lamp being inclosed in a steam-tight and water-tight casing and the switch being manipulated through a stuffing box.

744,923. MEANS FOR CONTROLLING ILLUMINATED ANNOUNCEMENT AND DISPLAY SIGNALS; Robert E. Lippincott, Worcester, Mass. App. filed Aug. 15, 1902. An electric sign switch operable by finger keys to display any word, letter or character desired.

744,924. ELECTRICAL SWITCH; Henry Lomax, Ralph Lomax and John Tomlinson, Darwen, England. App. filed Oct. 19, 1902. Details.

744,926. ELECTRIC CONDUCTOR; Albert E. Lytie, Chicago, Ill. App. filed April 20, 1901. A suspension connector consisting of a tube having internally threaded ends and a lateral, threaded external lug.

744,936. RECEIVER FOR WIRELESS TELEGRAPHS OR TELEPHONES; Andrew Plecher, Bristow, Va. App. filed Jan. 17, 1903. (See page 926.)

744,946. AUTOMATIC TELEPHONE EXCHANGE; William Baldwin Vansize, New York, N. Y. App. filed April 22, 1903. (See page 925.)

744,957. INCANDESCENT ELECTRIC LAMP BASE; Joseph E. Casey, Providence, R. I. App. filed July 20, 1903. To hold the center contact of a lamp base firmly in position, it is provided with a diametrical flange which engages with a groove in the porcelain disk.

744,974. ELECTRIC HEATER; James F. McElroy, Albany, N. Y. App. filed May 1, 1903. The core of the heater has two longitudinal passages, one for the retaining rod and the other for the return wire of the winding.

744,989. GALVANIC BATTERY; David L. Winters, Chicago, Ill. App. filed Oct. 5, 1903. (See page 923.)

745,010. INDICATOR FOR ROTARY SNAP SWITCHES; Monroe Guett, Hartford, Conn. App. filed Aug. 28, 1903. A lettered dial is movably attached to the cover of the switch and is engaged by the shaft so that the words "on" and "off" are properly displayed.

745,011. HANDLE FOR ELECTRIC SNAP SWITCHES; Monroe Guett, Hartford, Conn. App. filed Sept. 23, 1903. The invention resides in a handle of insulating material having a yoke so embedded within it that the inner edges of the legs of the yoke extend into the socket and receive the notched head of the stem and the plate which holds the spring under tension upon the stem.

745,019. TELEPHONY; Isidor Kitsee, Philadelphia, Pa. App. filed March 7, 1901. (See page 926.)

745,020. TROLLEY CONTROLLER; Walter B. Leecraft, Denison, Tex. App. filed Jan. 31, 1903. A fluid under pressure is used in connection with automatic mechanism operating when the trolley jumps from the wire to pull down the pole.

745,033. UNDERGROUND CONDUIT SYSTEM FOR ELECTRIC RAILWAYS; Andrew H. Angle, Philadelphia, Pa. App. filed July 3, 1902. The conductor sections are movable, the shoe forcing them downward to make connection with the feeder.

745,046. MOUNTING FOR THE COILS OF VOLTMETERS OR SIMILAR INSTRUMENTS; Charles W. Farquarson and Oscar F. Adelman, Chicago, Ill. App. filed Aug. 3, 1903. The mountings comprise fixed bearing pins at the ends of the core and jewels secured to the coil frame having their bearings on the pins.

745,049. TELEPHONE TRANSMITTER SUPPORT; Auguste Gamache, East Clifton, Canada. App. filed Nov. 24, 1902. (See page 927.)

745,077. RHEOSTAT; Walter A. Sherlock, San Francisco, Cal. App. filed Jan. 16, 1903. A double ended plug having a resistance material inserted between the ends and adapted for connection with any two sockets so as to interpose the resistance in the circuit.

745,114. LIGHTNING ARRESTER; Charles E. Nichols, Columbus, Ohio. App. filed April 6, 1903. A metallic tube through which a stretched wire passes centrally the tube being grounded.

745,122. REDUCTION OF METALS AND ALLOYS; Frank J. Tone, Niagara Falls, N. Y. App. filed Jan. 22, 1902. (See page 923.)

745,127. TROLLEY; Harry M. Williams and John W. Woomer, Pittsburg, Pa. App. filed Sept. 5, 1903. The guard arms carry auxiliary wheels in case the wire leaves the main wheel.

745,128. ELECTRICITY IN ELECTRIC THERAPEUTICS AND ELECTRIC TREATMENT; Louis Williams, Seattle, Wash. App. filed Nov. 4, 1901. A mattress or massage instrument having exposed contacts distributed over a surface to deliver broken current to the surface treated.

745,155. COMBINED SWITCH AND FUSE; George E. Clark, Detroit, Mich. App. filed March 11, 1903. A switch bar is formed by an inclosed fuse, the tube of which is provided with a large number of perforations to prevent heating of the fuse by the normal current.

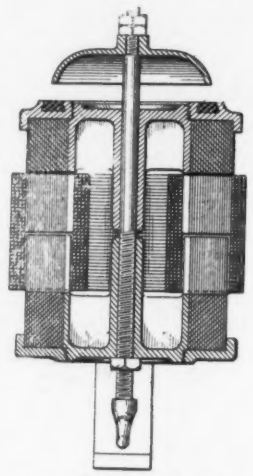
745,157. MEANS FOR OPERATING MOTOR VEHICLES; Clyde J. Coleman, New York, N. Y. App. filed Feb. 11, 1901. A small motor is used to start the engine after which the engine is connected to the driving gear and the small motor cut out.

745,168. SYSTEM FOR CONTROL OF ELECTRIC MOTORS; Arthur C. Eastwood, Cleveland, Ohio. App. filed July 16, 1903. (See Current News and Notes.)

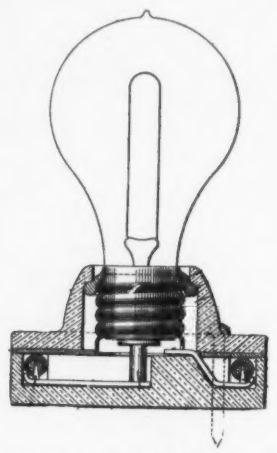
745,173. ELECTRICAL RECEPTACLE; Philip H. Fielding, New York, N. Y. App. filed May 29, 1902. A modification of the "Fielding" receptacle wherein the conductors are impaled upon brads to avoid removing the insulation, the construction being also weatherproof.

745,193. FLEXIBLE CONNECTOR FOR BATTERIES; Patrick Kennedy, New York, N. Y. App. filed June 30, 1903. (See page 923.)

745,194. REGULATOR FOR ELECTRIC CURRENTS; Patrick Kennedy, New York, N. Y. App. filed July 8, 1903. A regulator for car lighting cur-



744,773.—Elctro-Magnet.



745,173.—Electrical Receptacle.

rents wherein electro-magnets in lieu of solenoids, are used for controlling the pawls of the ratchet devices which operate the arms of the rheostat.

745,235. TELEPHONE ALARM SYSTEM; John D. Peachey, East Orange, N. J. App. filed Aug. 14, 1902. (See page 927.)

745,264. SURGICAL APPLIANCE; Albert V. Todd, Denver, Colo. App. filed May 29, 1903. An electrical device for treating the male organs.

745,274. ACCUMULATOR PLATE; Friedrich Wilhelm Buhne, Freiburg, Germany. App. filed Oct. 6, 1900. (See page 923.)

745,277. ELECTRIC TRAIN SIGNAL; William J. Hare and James P. Hare, Toronto, Canada. App. filed July 11, 1902. Details.

745,279. TYPE PRINTING TELEGRAPH; Frederick H. W. Higgins, London, England. App. filed Aug. 11, 1902. The impelling pallets for the escapement of the type wheel, are caused to strike quick sharp blows, which, it is claimed, increases the rapidity of operation.

745,280. CURRENT INTERRUPTER; Thomas A. Houghton, Rochester, N. Y. App. filed April 1, 1903. (See page 923.)

745,284. INSULATOR; Fred M. Locke, Victor, N. Y. App. filed May 5, 1902. Several petticoat shells are superposed in a manner to provide air chambers between them.

745,285. ELECTRIC RAILROAD BRAKE; John S. Lockwood, Kansas City, Mo. App. filed April 21, 1903. An electric brake in which a single helix actuates the rail and wheel shoes.

745,292. ALTERNATIVE CURRENT TELEPHONE; Andrew Plecher, Bristow, Va. App. filed Feb. 25, 1903. (See page 927.)

745,294. INCANDESCENT LAMP SOCKET; Guy H. Proctor, Somerville, Mass. App. filed Sept. 15, 1902. Details.

745,307. FLUID PRESSURE MECHANISM; John P. Coleman, Swissvale, Pa. App. filed May 21, 1902. This patent and those following relate to systems for operating railway signals by means of fluid pressure and electrically actuated valves and locking devices.

745,308. RAILWAY SIGNAL; John P. Coleman, Edgewood, Pa. App. filed Dec. 6, 1902. See preceding patent.

745,309. RAILWAY SIGNAL; John P. Coleman, Edgewood, Pa. App. filed Dec. 10, 1902. See patent No. 745,307.

THE ELECTRICAL WORLD AND ENGINEER'S

MOONLIGHT TABLES FOR 1904

COMPILED BY H. W. FRUND

These schedules are made up on local mean time. Where standard time is used, and it varies considerably from sun time, the proper deduction or addition must be made.

JANUARY, 1904

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	5.15 P.M.	1	12.00 M.	1	4.15 A.M.	1	6.20 A.M.
2	5.15 "	2	12.00 "	2	No light.	2	No light.
3	5.15 "	3	12.00 "	3	No light.	3	No light.
4	5.15 "	4	12.00 "	4	5.15 P.M.	4	7.50 P.M.
5	5.15 "	5	12.00 "	5	5.15 "	5	9.05 "
6	5.15 "	6	12.00 "	6	5.15 "	6	10.15 "
7	5.15 "	7	12.00 "	7	5.15 "	7	11.25 "
8	5.20 "	9	12.30 A.M.	8	5.20 "	8	12.30 A.M.
9	5.20 "	10	1.40 "	9	5.20 "	9	1.40 "
10	5.20 "	11	2.40 "	10	5.20 "	11	2.40 "
11	5.20 "	12	3.40 "	11	5.20 "	12	3.40 "
12	5.20 "	13	4.40 "	12	5.20 "	13	4.40 "
13	5.25 "	14	6.20 "	13	5.25 "	14	6.20 "
14	5.25 "	15	6.20 "	14	5.25 "	15	6.20 "
15	5.25 "	16	6.20 "	15	5.25 "	16	6.20 "
16	5.25 "	17	6.20 "	16	5.25 "	17	6.20 "
17	5.25 "	18	6.20 "	17	5.25 "	18	6.20 "
18	5.30 "	19	6.20 "	18	5.30 "	19	6.20 "
19	5.30 "	20	6.15 "	19	5.30 "	20	6.15 "
20	5.30 "	21	6.15 "	20	5.30 "	21	6.15 "
21	5.30 "	22	6.15 "	21	5.30 "	22	6.15 "
22	5.35 "	23	6.15 "	22	9.00 "	23	6.15 "
23	5.35 "	24	6.15 "	23	10.00 "	24	6.15 "
24	5.35 "	25	6.15 "	24	10.55 "	25	6.15 "
25	5.35 "	26	6.15 "	25	11.55 "	26	6.15 "
26	5.40 "	26	12.00 M.	26	—	—	—
27	12.55 A.M.	27	6.10 A.M.	27	12.55 A.M.	27	6.10 A.M.
27	5.40 P.M.	27	12.00 M.	28	2.00 "	28	6.10 "
28	2.00 A.M.	28	6.10 A.M.	29	3.00 "	29	6.10 "
28	5.40 P.M.	28	12.00 M.	30	4.00 "	30	6.10 "
29	5.40 "	29	12.00 "	31	No light.	31	No light.
30	5.45 "	30	12.00 "				
31	5.45 "	31	12.00 "				

FEBRUARY, 1904

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	5.45 P.M.	1	12.00 M.	1	No light.	1	No light.
2	5.45 "	2	12.00 "	2	5.45 P.M.	2	7.50 P.M.
3	5.45 "	3	12.00 "	3	5.45 "	3	9.05 "
4	5.50 "	4	12.00 "	4	5.50 "	4	10.15 "
5	5.50 "	5	12.00 "	5	5.50 "	5	11.25 "
6	5.50 "	6	12.00 "	6	5.50 "	7	12.30 A.M.
7	5.50 "	8	1.35 A.M.	7	5.50 "	8	1.35 "
8	5.55 "	9	2.35 "	8	5.55 "	9	2.35 "
9	5.55 "	10	3.30 "	9	5.55 "	10	3.30 "
10	5.55 "	11	4.25 "	10	5.55 "	11	4.25 "
11	5.55 "	12	5.10 "	11	5.55 "	12	5.10 "
12	6.00 "	13	6.00 "	12	6.00 "	13	6.00 "
13	6.00 "	14	6.00 "	13	6.00 "	14	6.00 "
14	6.00 "	15	5.55 "	14	6.00 "	15	5.55 "
15	6.00 "	16	5.55 "	15	6.00 "	16	5.55 "
16	6.05 "	17	5.55 "	16	6.05 "	17	5.55 "
17	6.05 "	18	5.55 "	17	6.05 "	18	5.55 "
18	6.05 "	19	5.50 "	18	6.05 "	19	5.50 "
19	6.05 "	20	5.50 "	19	6.05 "	20	5.50 "
20	6.10 "	21	5.50 "	20	6.05 "	21	5.50 "
21	6.10 "	22	5.45 "	21	9.45 "	22	5.50 "
22	6.10 "	23	5.45 "	22	10.45 "	23	5.45 "
23	6.10 "	24	5.45 "	23	11.45 "	24	5.45 "
24	6.15 "	24	12.00 M.	—	—	—	—
25	12.45 A.M.	25	5.45 A.M.	25	12.45 A.M.	25	5.45 "
25	6.15 P.M.	25	12.00 M.	26	1.45 "	26	5.40 "
26	1.45 A.M.	26	5.40 A.M.	27	2.40 "	27	5.40 "
26	6.15 P.M.	26	12.00 M.	28	3.30 "	28	5.40 "
27	6.15 "	27	12.00 "	29	4.20 "	29	5.35 "
28	6.20 "	28	12.00 "				
29	6.20 "	29	12.00 "				

MARCH, 1904

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	6.20 P.M.	1	12.00 M.	1	No light.	1	No light.
2	6.20 "	2	12.00 "	2	6.20 P.M.	2	7.50 P.M.
3	6.20 "	3	12.00 "	3	6.20 "	3	9.00 "
4	6.25 "	4	12.00 "	4	6.25 "	4	10.10 "
5	6.25 "	5	12.00 "	5	6.25 "	5	11.20 "
6	6.25 "	7	12.20 A.M.	6	6.25 "	7	12.20 A.M.
7	6.25 "	8	1.20 "	7	6.25 "	8	1.20 "
8	6.30 "	9	2.20 "	8	6.25 "	9	2.20 "
9	6.30 "	10	3.10 "	9	6.30 "	10	3.10 "
10	6.30 "	11	3.55 "	10	6.30 "	11	3.55 "
11	6.30 "	12	4.35 "	11	6.30 "	12	4.35 "
12	6.30 "	13	5.10 "	12	6.30 "	13	5.10 "
13	6.30 "	14	5.10 "	13	6.30 "	14	5.10 "
14	6.35 "	15	5.15 "	14	6.35 "	15	5.15 "
15	6.35 "	16	5.15 "	15	6.35 "	16	5.15 "
16	6.35 "	17	5.15 "	16	6.35 "	17	5.15 "
17	6.35 "	18	5.10 "	17	6.35 "	18	5.10 "
18	6.40 "	19	5.10 "	18	6.40 "	19	5.10 "
19	6.40 "	20	5.05 "	19	6.40 "	20	5.05 "
20	6.40 "	21	5.05 "	20	6.40 "	21	5.05 "
21	6.40 "	22	5.05 "	21	6.40 "	22	5.05 "
22	6.40 "	23	5.00 "	22	10.40 "	23	5.00 "
23	6.45 "	24	5.00 "	23	11.35 "	24	5.00 "
24	6.45 "	25	4.55 "	24	—	—	—
25	6.45 "	26	4.55 "	25	12.30 A.M.	25	4.55 "
26	6.45 "	26	12.00 M.	26	1.20 "	26	4.55 "
27	2.10 A.M.	27	4.55 A.M.	27	2.10 "	27	4.55 "
27	6.45 P.M.	27	12.00 M.	28	2.55 "	28	4.55 "
28	6.50 "	28	12.00 "	29	3.35 "	29	4.55 "
29	6.50 "	29	12.00 "	30	No light.	30	No light.
30	6.50 "	30	12.00 "	31	No light.	31	No light.
31	6.50 "	31	12.00 "				

APRIL, 1904

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	6.50 P.M.	1	12.00 M.	1	6.50 P.M.	1	9.00 P.M.
2	6.55 "	2	12.00 "	2	6.55 "	2	10.00 "
3	6.55 "	3	12.00 "	3	6.55 "	3	11.10 "
4	6.55 "	4	12.00 "	4	6.55 "	5	12.10 A.M.
5	6.55 "	6	1.00 A.M.	5	6.55 "	6	1.00 "
6	6.55 "	7	1.50 "	6	6.55 "	7	1.50 "
7	7.00 "	8	2.30 "	7	7.00 "	8	2.30 "
8	7.00 "	9	3.10 "	8	7.00 "	9	3.10 "
9	7.00 "	10	3.45 "	9	7.00 "	10	3.45 "
10	7.00 "	11	4.20 "	10	7.00 "	11	4.20 "
11	7.00 "	12	4.30 "	11	7.00 "	12	4.30 "
12	7.05 "	13	4.30 "	12	7.05 "	13	4.30 "
13	7.05 "	14	4.25 "	13	7.05 "	14	4.25 "
14	7.05 "	15	4.25 "	14	7.05 "	15	4.25 "
15	7.05 "	16	4.25 "	15	7.05 "	16	4.25 "
16	7.05 "	17	4.25 "	16	7.05 "	17	4.25 "
17	7.10 "	18	4.20 "	17	7.10 "	18	4.20 "
18	7.10 "	19	4.20 "	18	7.10 "	19	4.20 "
19	7.10 "	20	4.20 "	19	7.10 "	20	4.20 "
20	7.10 "	21	4.15 "	20	10.30 "	21	4.15 "
21	7.10 "	22	4.15 "	21	11.20 "	22	4.15 "
22	7.15 "	23	4.15 "	22	—	—	—
23	7.15 "	23	12.00 M.	23	12.10 A.M.	23	4.15 "
24	12.50 A.M.	24	4.15 A.M.	24	12.50 "	24	4.15 "
24	7.15 P.M.	24	12.00 M.	25	1.30 "	25	4.10 "
25	1.30 A.M.	25	4.10 A.M.	26	2.10 "	26	4.10 "
25	7.15 P.M.	25	12.00 M.	27	2.50 "	27	4.10 "
26	7.15 "	26	12.00 "	28	No light.	28	No light.
27	7.20 "	27	12.00 "	29	No light.	29	No light.
28	7.20 "	28	12.00 "	30	7.20 P.M.	30	8.50 P.M.
29	7.20 "	29	12.00 "				
30	7.20 "	30	12.00 "				

MAY, 1904

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	7.20 P.M.	1	12.00 M.	1	7.20 P.M.	1	9.50 P.M.
2	7.25 "	2	12.00 "	2	7.25 "	2	10.50 "
3	7.25 "	3	12.00 "	3	7.25 "	3	11.40 "
4	7.25 "	5	12.30 A.M.	4	7.25 "	5	12.30 A.M.
5	7.25 "	6	1.10 "	5	7.25 "	6	1.10 "
6	7.25 "	7	1.50 "	6	7.25 "	7	1.50 "
7	7.30 "	8	2.20 "	7	7.30 "	8	2.20 "
8	7.30 "	9	2.50 "	8	7.30 "	9	2.50 "
9	7.30 "	10	3.20 "	9	7.30 "	10	3.20 "
10	7.30 "	11	3.50 "	10	7.30 "	11	3.50 "
11	7.30 "	12	3.50 "	11	7.30 "	12	3.50 "
12	7.35 "	13	3.50 "	12	7.35 "	13	3.50 "
13	7.35 "	14	3.50 "	13	7.35 "	14	3.50 "
14	7.35 "	15	3.50 "	14	7.35 "	15	3.50 "
15	7.35 "	16	3.45 "	15	7.35 "	16	3.45 "
16	7.35 "	17	3.45 "	16	7.35 "	17	3.45 "
17	7.35 "	18	3.45 "	17	7.35 "	18	3.45 "
18	7.40 "	19	3.45 "	18	7.40 "	19	3.45 "
19	7.40 "	20	3.45 "	19	7.40 "	20	3.45 "
20	7.40 "	21	3.40 "	20	10.50 P.M.	21	3.40 "
21	7.40 "	22	3.40 "	21	11.30 "	22	3.40 "
22	7.40 "	23	3.40 "	22	—	—	—
23	7.45 "	24	3.40 "	23	12.10 A.M.	23	3.40 A.M.
24	7.45 "	24	12.00 M.	24	12.50 "	24	3.40 "
25	1.20 A.M.	25	3.40 A.M.	25	1.20 "	25	3.40 "
25	7.45 P.M.	25	12.00 M.	26	2.00 "	26	3.40 "
26	7.45 "	26	12.00 "	27	2.40 "	27	3.40 "
27	7.45 "	27	12.00 "	28	No light.	28	No light.
28	7.45 "	28	12.00 "	29	No light.	29	No light.
29	7.45 "	29	12.00 "	30	7.50 P.M.	30	9.30 P.M.
30	7.50 "	30	12.00 "	31	7.50 "	31	10.20 "
31	7.50 "	31	12.00 "				

JUNE, 1904

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	7.50 P.M.	1	12.00 M.	1	7.50 P.M.	1	11.00 P.M.
2	7.50 "	2	12.00 "	2	7.50 "	2	11.45 "
3	7.50 "	4	12.20 A.M.	3	7.50 "	4	12.20 A.M.
4	7.50 "	5	12.50 "	4	7.50 "	5	12.50 "
5	7.50 "	6	1.20 "	5	7.50 "	6	1.20 "
6	7.55 "	7	1.50 "	6	7.55 "	7	1.50 "
7	7.55 "	8	2.20 "	7	7.55 "	8	2.20 "
8	7.55 "	9	2.50 "	8	7.55 "	9	2.50 "
9	7.55 "	10	3.30 "	9	7.55 "	10	3.30 "
10	7.55 "	11	3.30 "	10	7.55 "	11	3.30 "
11	7.55 "	12	3.30 "	11	7.55 "	12	3.30 "
12	7.55 "	13	3.30 "	12	7.55 "	13	3.30 "
13	7.55 "	14	3.30 "	13	7.55 "	14	3.30 "
14	7.55 "	15	3.30 "	14	7.55 "	15	3.30 "
15	7.55 "	16	3.30 "	15	7.55 "	16	3.30 "
16	8.00 "	17	3.30 "	16	7.55 "	17	3.30 "
17	8.00 "	18	3.30 "	17	7.55 "	18	3.30 "
18	8.00 "	19	3.30 "	18	10.10 "	19	3.30 "
19	8.00 "	20	3.30 "	19	10.50 "	20	3.30 "
20	8.00 "	21	3.30 "	20	11.25 "	21	3.30 "
21	8.00 "	22	3.30 "	—	—	—	—
22	8.00 "	22	12.00 M.	22	12.05 A.M.	22	3.30 "
23	12.40 A.M.	23	3.30 A.M.	23	12.40 "	23	3.30 "
23	8.00 P.M.	23	12.00 M.	24	1.15 "	24	3.30 "
24	8.00 "	24	12.00 "	25	2.00 "	25	3.30 "
25	8.00 "	25	12.00 "	26	No light.	26	No light.
26	8.00 "	26	12.00 "	27	No light.	27	No light.
27	8.00 "	27	12.00 "	28	No light.	28	No light.
28	8.00 "	28	12.00 "	29	8.00 P.M.	29	9.40 P.M.
29	8.00 "	29	12.00 "	30	8.00 "	30	10.20 "
30	8.00 "	30	12.00 "				

JULY, 1904

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	8.00 P.M.	1	12.00 M.	1	8.00 P.M.	1	10.50 P.M.
2	8.00 "	2	12.00 "	2	8.00 "	2	11.25 "
3	8.00 "	3	12.00 "	3	8.00 "	3	11.55 "
4	8.00 "	5	12.25 A.M.	4	8.00 "	5	12.25 A.M.
5	8.00 "	6	12.55 "	5	8.00 "	6	12.55 "
6	8.00 "	7	1.25 "	6	8.00 "	7	1.25 "
7	8.00 "	8	2.00 "	7	8.00 "	8	2.00 "
8	8.00 "	9	2.35 "	8	8.00 "	9	2.35 "
9	8.00 "	10	3.20 "	9	8.00 "	10	3.20 "
10	8.00 "	11	3.40 "	10	8.00 "	11	3.40 "
11	8.00 "	12	3.40 "	11	8.00 "	12	3.40 "
12	8.00 "	13	3.40 "	12	8.00 "	13	3.40 "
13	8.00 "	14	3.40 "	13	8.00 "	14	3.40 "
14	8.00 "	15	3.40 "	14	8.00 "	15	3.40 "
15	8.00 "	16	3.40 "	15	8.00 "	16	3.40 "
16	8.00 "	17	3.40 "	16	8.00 "	17	3.40 "
17	8.00 "	18	3.40 "	17	8.00 "	18	3.40 "
18	8.00 "	19	3.45 "	18	10.00 "	19	3.45 "
19	7.55 "	20	3.45 "	19	10.40 "	20	3.45 "
20	7.55 "	21	3.45 "	20	11.20 "	21	3.45 "
21	7.55 "	22	3.45 "	21	11.55 "	22	3.45 "
22	7.55 "	22	12.00 M.	22	—	—	—
23	12.45 A.M.	23	3.50 A.M.	23	12.45 A.M.	23	3.50 "
23	7.55 P.M.	23	12.00 M.	24	1.30 "	24	3.50 "
24	7.55 "	24	12.00 "	25	2.20 "	25	3.50 "
25	7.55 "	25	12.00 "	26	No light.	26	No light.
26	7.50 "	26	12.00 "	27	No light.	27	No light.
27	7.50 "	27	12.00 "	28	No light.	28	No light.
28	7.50 "	28	12.00 "	29	7.50 P.M.	29	9.30 P.M.
29	7.50 "	29	12.00 "	30	7.50 "	30	10.00 "
30	7.50 "	30	12.00 "	31	7.45 "	31	10.25 "
31	7.45 "	31	12.00 "				

AUGUST, 1904

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	7.45 P.M.	1	12.00 M.	1	7.45 P.M.	1	10.50 P.M.
2	7.45 "	2	12.00 "	2	7.45 "	2	11.25 "
3	7.45 "	3	12.00 "	3	7.45 "	3	11.55 "
4	7.45 "	5	12.35 A.M.	4	7.45 "	5	12.35 A.M.
5	7.40 "	6	1.10 "	5	7.40 "	6	1.10 "
6	7.40 "	7	2.00 "	6	7.40 "	7	2.00 "
7	7.40 "	8	2.50 "	7	7.40 "	8	2.50 "
8	7.40 "	9	3.50 "	8	7.40 "	9	3.50 "
9	7.35 "	10	4.05 "	9	7.35 "	10	4.05 "
10	7.35 "	11	4.05 "	10	7.35 "	11	4.05 "
11	7.35 "	12	4.05 "	11	7.35 "	12	4.05 "
12	7.35 "	13	4.05 "	12	7.35 "	13	4.05 "
13	7.30 "	14	4.05 "	13	7.30 "	14	4.05 "
14	7.30 "	15	4.10 "	14	7.30 "	15	4.10 "
15	7.30 "	16	4.10 "	15	7.30 "	16	4.10 "
16	7.30 "	17	4.10 "	16	9.20 "	17	4.10 "
17	7.25 "	18	4.10 "	17	10.00 "	18	4.10 "
18	7.25 "	19	4.10 "	18	10.40 "	19	4.10 "
19	7.25 "	20	4.15 "	19	11.30 "	20	4.15 "
20	7.25 "	21	4.15 "	20	—	—	—
21	7.20 "	21	12.00 M.	21	12.20 A.M.	21	4.15 A.M.
22	7.20 "	22	12.00 "	22	1.10 "	22	4.15 "
23	7.20 "	23	12.00 "	23	2.00 "	23	4.15 "
24	7.15 "	24	12.00 "	24	3.00 "	24	4.20 "
25	7.15 "	25	12.00 "	25	No light.	25	No light.
26	7.15 "	26	12.00 "	26	No light.	26	No light.
27	7.10 "	27	12.00 "	27	7.10 P.M.	27	8.30 P.M.
28	7.10 "	28	12.00 "	28	7.10 "	28	9.00 "
29	7.10 "	29	12.00 "	29	7.10 "	29	9.30 "
30	7.10 "	30	12.00 "	30	7.10 "	30	10.00 "
31	7.05 "	31	12.00 "	31	7.05 "	31	10.30 "

SEPTEMBER, 1904

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	7.05 P.M.	1	12.00 M.	1	7.05 P.M.	1	11.10 P.M.
2	7.05 "	2	1200 "	2	7.05 "	2	11.50 "
3	7.00 "	4	12.40 A.M.	3	7.00 "	4	12.40 A.M.
4	7.00 "	5	1.35 "	4	7.00 "	5	1.35 "
5	7.00 "	6	2.35 "	5	7.00 "	6	2.35 "
6	6.55 "	7	3.40 "	6	6.55 "	7	3.40 "
7	6.55 "	8	4.30 "	7	6.55 "	8	4.30 "
8	6.55 "	9	4.30 "	8	6.55 "	9	4.30 "
9	6.50 "	10	4.35 "	9	6.50 "	10	4.35 "
10	6.50 "	11	4.35 "	10	6.50 "	11	4.35 "
11	6.50 "	12	4.35 "	11	6.50 "	12	4.35 "
12	6.45 "	13	4.35 "	12	6.45 "	13	4.35 "
13	6.45 "	14	4.35 "	13	6.45 "	14	4.35 "
14	6.45 "	15	4.35 "	14	8.40 "	15	4.35 "
15	6.40 "	16	4.40 "	15	9.20 "	16	4.40 "
16	6.40 "	17	4.40 "	16	10.15 "	17	4.40 "
17	6.40 "	18	4.40 "	17	11.05 "	18	4.40 "
18	6.35 "	19	4.40 "	18	12.00 M.	19	4.40 "
19	6.35 "	19	12.00 M.	19	—	—	—
20	12.50 A.M.	20	4.40 A.M.	20	12.50 A.M.	20	4.40 "
20	6.35 P.M.	20	12.00 M.	21	1.50 "	21	4.45 "
21	6.35 "	21	12.00 "	22	2.45 "	22	4.45 "
22	6.30 "	22	12.00 "	23	3.40 "	23	4.45 "
23	6.30 "	23	12.00 "	24	No light.	24	No light.
24	6.25 "	24	12.00 "	25	No light.	25	No light.
25	6.25 "	25	12.00 "	26	6.25 P.M.	26	8.00 P.M.
26	6.25 "	26	12.00 "	27	6.25 "	27	8.35 "
27	6.25 "	27	12.00 "	28	6.20 "	28	9.10 "
28	6.20 "	28	12.00 "	29	6.20 "	29	9.50 "
29	6.20 "	29	12.00 "	30	6.15 "	30	10.30 "
30	6.15 "	30	12.00 "				

OCTOBER, 1904

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	8.00 P.M.	1	12.00 M.	1	8.00 P.M.	1	10.50 P.M.
2	8.00 "	2	12.00 "	2	8.00 "	2	11.25 "
3	8.00 "	3	12.00 "	3	8.00 "	3	11.55 "
4	8.00 "	4	12.25 A.M.	4	8.00 "	5	12.25 A.M.
5	8.00 "	5	12.55 "	5	8.00 "	6	12.55 "
6	8.00 "	7	1.25 "	6	8.00 "	7	1.25 "
7	8.00 "	8	2.00 "	7	8.00 "	8	2.00 "
8	8.00 "	9	2.35 "	8	8.00 "	9	2.35 "
9	8.00 "	10	3.20 "	9	8.00 "	10	3.20 "
10	8.00 "	11	3.40 "	10	8.00 "	11	3.40 "
11	8.00 "	12	3.40 "	11	8.00 "	12	3.40 "
12	8.00 "	13	3.40 "	12	8.00 "	13	3.40 "
13	8.00 "	14	3.40 "	13	8.00 "	14	3.40 "
14	8.00 "	15	3.40 "	14	8.00 "	15	3.40 "
15	8.00 "	16	3.40 "	15	8.00 "	16	3.40 "
16	8.00 "	17	3.40 "	16	8.00 "	17	3.40 "
17	8.00 "	18	3.40 "	17	8.00 "	18	3.40 "
18	8.00 "	19	3.45 "	18	10.00 "	19	3.45 "
19	7.55 "	20	3.45 "	19	10.40 "	20	3.45 "
20	7.55 "	21	3.45 "	20	11.20 "	21	3.45 "
21	7.55 "	22	3.45 "	21	11.55 "	22	3.45 "
22	7.55 "	22	12.00 M.	22	—	—	—
23	12.45 A.M.	23	3.50 A.M.	23	12.45 A.M.	23	3.50 "
23	7.55 P.M.	23	12.00 M.	24	1.30 "	24	3.50 "
24	7.55 "	24	12.00 "	25	2.20 "	25	3.50 "
25	7.55 "	25	12.00 "	26	No light.	26	No light.
26	7.50 "	26	12.00 "	27	No light.	27	No light.
27	7.50 "	27	12.00 "	28	No light.	28	No light.
28	7.50 "	28	12.00 "	29	7.50 P.M.	29	9.30 P.M.
29	7.50 "	29	12.00 "	30	7.50 "	30	10.00 "
30	7.50 "	30	12.00 "	31	7.45 "	31	10.25 "
31	7.45 "	31	12.00 "				

NOVEMBER, 1904

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	7.45 P.M.	1	12.00 M.	1	7.45 P.M.	1	10.50 P.M.
2	7.45 "	2	12.00 "	2	7.45 "	2	11.25 "
3	7.45 "	3	12.00 "	3	7.45 "	3	11.55 "
4	7.45 "	5	12.35 A.M.	4	7.45 "	5	12.35 A.M.

OCTOBER, 1904

Table No. 1.
Frund's Moonlight System.

Date.	Light.	Date.	Exting.
1	6.15 P.M.	1	12.00 M.
2	6.15 "	3	12.25 A.M.
3	6.10 "	4	1.25 "
4	6.10 "	5	2.30 "
5	6.10 "	6	3.40 "
6	6.05 "	7	4.50 "
7	6.05 "	8	5.00 "
8	6.05 "	9	5.00 "
9	6.05 "	10	5.00 "
10	6.00 "	11	5.05 "
11	6.00 "	12	5.05 "
12	6.00 "	13	5.05 "
13	5.55 "	14	5.05 "
14	5.55 "	15	5.05 "
15	5.55 "	16	5.10 "
16	5.50 "	17	5.10 "
17	5.50 "	18	5.10 "
18	5.50 "	18	12.00 M.
19	12.40 A.M.	19	5.10 A.M.
19	5.50 P.M.	19	12.00 M.
20	1.30 A.M.	20	5.15 A.M.
20	5.45 P.M.	20	12.00 M.
21	5.45 "	21	12.00 "
22	5.45 "	22	12.00 "
23	5.40 "	23	12.00 "
24	5.40 "	24	12.00 "
25	5.40 "	25	12.00 "
26	5.40 "	26	12.00 "
27	5.35 "	27	12.00 "
28	5.35 "	28	12.00 "
29	5.35 "	29	12.00 "
30	5.35 "	30	12.00 "
31	5.30 "	31	12.00 "

Table No. 2.
Standard Moonlight System.

Date.	Light.	Date.	Exting.
1	6.15 P.M.	1	11.30 P.M.
2	6.15 "	3	12.25 A.M.
3	6.10 "	4	1.25 "
4	6.10 "	5	2.30 "
5	6.10 "	6	3.40 "
6	6.05 "	7	4.50 "
7	6.05 "	8	5.00 "
8	6.05 "	9	5.00 "
9	6.05 "	10	5.00 "
10	6.00 "	11	5.05 "
11	6.00 "	12	5.05 "
12	6.00 "	13	5.05 "
13	5.55 "	14	5.05 "
14	9.00 "	15	5.05 "
15	9.50 "	16	5.10 "
16	10.50 "	17	5.10 "
17	11.40 "	18	5.10 "
18	——	——	——
19	12.40 A.M.	19	5.10 "
20	1.30 "	20	5.15 "
21	2.30 "	21	5.15 "
22	3.20 "	22	5.15 "
23	4.20 "	23	5.15 "
24	No light.	24	No light.
25	No light.	25	No light.
26	5.35 P.M.	26	7.30 P.M.
27	5.35 "	27	8.30 "
28	5.35 "	28	9.20 "
29	5.35 "	29	10.20 "
30	5.35 "	30	11.20 "
31	5.30 "	1	12.20 A.M.

NOVEMBER, 1904

Table No. 1.
Frund's Moonlight System.

Date.	Light.	Date.	Exting.
1	5.30 P.M.	2	1.25 A.M.
2	5.30 "	3	2.35 "
3	5.30 "	4	3.45 "
4	5.25 "	5	5.00 "
5	5.25 "	6	5.30 "
6	5.25 "	7	5.35 "
7	5.25 "	8	5.35 "
8	5.20 "	9	5.35 "
9	5.20 "	10	5.35 "
10	5.20 "	11	5.40 "
11	5.20 "	12	5.40 "
12	5.20 "	13	5.40 "
13	5.20 "	14	5.40 "
14	5.15 "	15	5.40 "
15	5.15 "	16	5.40 "
16	5.15 "	17	5.40 "
17	5.15 "	17	12.00 M.
18	1.15 A.M.	18	5.40 A.M.
18	5.15 P.M.	18	12.00 M.
19	5.15 "	19	12.00 "
20	5.15 "	20	12.00 "
21	5.10 "	21	12.00 "
22	5.10 "	22	12.00 "
23	5.10 "	23	12.00 "
24	5.10 "	24	12.00 "
25	5.10 "	25	12.00 "
26	5.10 "	26	12.00 "
27	5.10 "	27	12.00 "
28	5.10 "	28	12.00 "
29	5.10 "	30	12.20 A.M.
30	5.05 "	1	1.30 "

Table No. 2.
Standard Moonlight System.

Date.	Light.	Date.	Exting.
1	5.30 P.M.	2	1.25 A.M.
2	5.30 "	3	2.35 "
3	5.30 "	4	3.45 "
4	5.25 "	5	5.00 "
5	5.25 "	6	5.30 "
6	5.25 "	7	5.35 "
7	5.25 "	8	5.35 "
8	5.20 "	9	5.35 "
9	5.20 "	10	5.35 "
10	5.20 "	11	5.40 "
11	7.40 "	12	5.40 "
12	8.30 "	13	5.40 "
13	9.30 "	14	5.40 "
14	10.30 "	15	5.40 "
15	11.20 "	16	5.40 "
16	——	——	——
17	12.20 A.M.	17	5.40 "
18	1.15 "	18	5.40 "
19	2.10 "	19	5.40 "
20	3.10 "	20	5.50 "
21	No light.	21	No light.
22	No light.	22	No light.
23	No light.	23	No light.
24	5.10 P.M.	24	7.20 P.M.
25	5.10 "	25	8.10 "
26	5.10 "	26	9.10 "
27	5.10 "	27	10.10 "
28	5.10 "	28	11.20 "
29	5.10 "	30	12.20 A.M.
30	5.05 "	1	1.30 "

DECEMBER, 1904

Table No. 1.
Frund's Moonlight System.

Date.	Light.	Date.	Exting.
1	5.05 P.M.	2	2.40 A.M.
2	5.05 "	3	3.50 "
3	5.05 "	4	4.00 "
4	5.05 "	5	6.05 "
5	5.05 "	6	6.05 "
6	5.05 "	7	6.05 "
7	5.05 "	8	6.05 "
8	5.05 "	9	6.10 "
9	5.05 "	10	6.10 "
10	5.05 "	11	6.10 "
11	5.05 "	12	6.10 "
12	5.05 "	13	6.10 "
13	5.05 "	14	6.10 "
14	5.05 "	15	6.15 "
15	5.05 "	16	6.15 "
16	5.05 "	16	12.00 M.
17	12.55 A.M.	17	6.15 A.M.
17	5.05 P.M.	17	12.00 M.
18	1.50 A.M.	18	6.15 A.M.
18	5.05 P.M.	18	12.00 M.
19	5.05 "	19	12.00 "
20	5.05 "	20	12.00 "
21	5.05 "	21	12.00 "
22	5.05 "	22	12.00 "
23	5.05 "	23	12.00 "
24	5.05 "	24	12.00 "
25	5.10 "	25	12.00 "
26	5.10 "	26	12.00 "
27	5.10 "	27	12.00 "
28	5.10 "	29	12.30 A.M.
29	5.10 "	30	1.40 "
30	5.10 "	31	2.50 "
31	5.10 "	1	4.00 "

Table No. 2.
Standard Moonlight System.

Date.	Light.	Date.	Exting.
1	5.05 P.M.	2	2.40 A.M.
2	5.05 "	3	3.50 "
3	5.05 "	4	5.00 "
4	5.05 "	5	6.05 "
5	5.05 "	6	6.05 "
6	5.05 "	7	6.05 "
7	5.05 "	8	6.05 "
8	5.05 "	9	6.10 "
9	5.05 "	10	6.10 "
10	5.05 "	11	6.10 "
11	8.15 "	12	6.10 "
12	9.10 "	13	6.10 "
13	10.10 "	14	6.10 "
14	11.00 "	15	6.15 "
15	12.00 M.	16	6.15 "
16	——	——	——
17	12.55 A.M.	17	6.15 "
18	1.50 "	18	6.15 "
19	2.50 "	19	6.15 "
20	3.50 "	20	6.15 "
21	4.50 "	21	6.15 "
22	No light.	22	No light.
23	No light.	23	No light.
24	5.05 P.M.	24	8.00 P.M.
25	5.10 "	25	9.00 "
26	5.10 "	26	10.10 "
27	5.10 "	7	11.20 "
28	5.10 "	29	12.30 A.M.
29	5.10 "	30	1.40 "
30	5.10 "	31	2.50 "
31	5.10 "	1	4.00 "